

SAJOUS'S ANALYTIC CYCLOPEDIA OF PRACTICAL MEDICINE

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SAJOUS'S ANALYTIC CYCLOPEDIA of PRACTICAL MEDICINE

R

RHEUMATISM.—A group of affections, sometimes of parasitic origin, characterized by pain and swelling of the joints and muscles, and which may be acute or chronic. Under this term may be grouped rheumatic fever, muscular rheumatism, and various joint manifestations dependent upon specific infections such as gonorrhea, scarlatina, diphtheria, etc. Of these conditions, the first three will be considered *seriatim* in this article.

Rheumatoid arthritis or, according to the newer classification of Goldthwait, (1) chronic atrophic arthritis, and (2) chronic hypertrophic arthritis, have been considered in the article on JOINTS, SURGICAL DISEASES OF, in vol. vi.

RHEUMATIC FEVER.

Rheumatic fever (*acute or subacute rheumatism; acute articular rheumatism*), is an acute and subacute infectious, febrile disease, characterized by migratory, multiple arthritis, sweating, and a tendency to complicating inflammation of the serous membranes and the fibrous tissues, and to recurrence.

SYMPTOMS.—Rheumatic fever rarely presents marked prodromal

symptoms, but ordinarily the patient feels weary and ill for from one to three days. Occasionally fugitive pains, sore throat, or otitis media precede the onset of the disease. The symptoms of the acute affection then set in suddenly with chills, which may be repeated once or twice. Fever appears and the temperature rises to 39° or 40° C. (102.2° or 104° F.); the pulse and respiration are accelerated, the tongue furred; there is no appetite, but thirst is marked. The urine is scanty, highly acid, and loaded with urates, which give it a dark-red color and rapidly precipitate; the specific gravity of the urine is high, and it is not rare to observe albuminuria on the first days of the disease. Chemical examination demonstrates that urea as well as uric acid is present in excessive quantity. Hemoglobinuria, peptonuria, urobilinuria, and cystinuria have sometimes been observed.

The skin is covered with abundant perspiration and numerous sudamina and miliaria often appear on it. The sweat is acid and of a peculiar odor.

Simultaneously with the fever the characteristic signs of rheumatic arthritis appear, generally in the articu-

lations of the foot or the knee. Frequently the affection begins in the ankle-joint, and after some days the process also invades the knee, the shoulder, the elbow-joint, and the wrist. Occasionally the affection begins in the joints of the upper extremities. This, when it is the case, ordinarily occurs in persons occupied in hard bodily work. The larger joints are most frequently affected, but sometimes the small joints of the fingers and toes are also involved, especially in children. A single joint rarely continues to be the seat of trouble for more than four or five days; the affection then more or less suddenly disappears, commonly during the night, and one or more other joints are attacked in turn. At one time several joints may be involved to a varying extent. In very severe cases almost all joints may be affected simultaneously, and even the articulations of the jaws, the spine, and the ribs may be painful and swollen. Ordinarily rheumatic fever attacks several articulations, but mono-articular acute rheumatism has also been observed.

According to statistics, the localization of the disease in the different joints is as follows: Ankle, 27.8 per cent.; knee, 17.9 per cent.; wrist, 9.6 per cent.; shoulder, 6.2 per cent.; hip, 4.1 per cent.; metatarsus, 3.7 per cent.; elbow, 2.2 per cent.; metacarpus, 1.2 per cent.; toes, 0.8 per cent.; fingers, 0.8 per cent.

Analyzing 100 cases of so-called "rheumatism," the author found that these included 44 cases of arthritis and 3 of muscular rheumatism to which the term "rheumatism" might be fairly applicable. Thirty of the 44 patients gave a history of gonorrhea. Among the 53 incorrectly

diagnosed cases there were 18 of syphilis, with a positive Wassermann, 8 of neuritis, 4 of tuberculosis, 4 of flat foot, 3 typical cases of pellagra, 2 each of neurasthenia, arteriosclerosis, sciatica, and tabes, and 1 each of chronic nephritis, chronic gastritis, muscular atrophy, malaria, pernicious anemia, and myelitis. Deaderick (South. Med. Jour., Dec., 1918).

The affected joints are very painful and swollen; the overlying skin is red, hot, tense, and edematous, while pressure upon it leaves an impression which remains visible for some time. Swelling of the joint is caused principally by edema of the skin and ligaments, but occasionally also by an effusion in the articulation itself. Upon moving the diseased articulation a crackling sound is sometimes heard; this is commonly caused by the inflammatory changes in the tendons and their synovial membranes. Moving and even touching the affected joints is very painful to the patient; in severe cases the pain may be occasioned by very small commotions, *e.g.*, by walking over the floor of the sick-room. The pain seems to be localized in the tendons and the muscles in the proximity of the joint. When the patient is induced to keep completely quiet, slight movements of the diseased joint may be passively executed without causing any pain, whereas the most trifling active movement is accompanied by excruciating pain.

The skin over the affected articulation shows increased sensibility to changes of temperature, but a diminished sensibility to faradic irritation.

Of diagnostic importance in the cases in which they are present are small nodules—"rheumatic nodules"—1 to 4 mm. in diameter, generally

not tender, appearing in areas where bones underlie the skin or in the synovial sheaths of tendons. These occur especially in children. They may disappear rapidly or only after some months. Fibrosis may occur in them.

The temperature of the patient is elevated in proportion to the number of the affected articulations; in uncomplicated cases it seldom rises above 39° to 40° C. (102.2° to 104° F.), but it may also oscillate between 38° and 39° C. (100.4° and 102.2° F.). Acid sweats often take place consentaneously with remissions in the temperature.

One of the earliest and most constant and obscure symptoms of rheumatism in children is a persistent low fever, dropping daily to normal, occasionally below, and seldom going above 100° F. The child usually feels well, looks well, and the condition is only accidentally discovered. The first suggestion occurs after an illness during which time there has been elevation of temperature, but as the other symptoms clear up the temperature chart reveals the persistence of a small amount of unaccountable fever. A complete examination may disclose no symptoms other than slight acceleration of the heart on exertion. One naturally thinks of tuberculosis, but gets a negative von Pirquet. Poynton considers this temperature an important diagnostic symptom of very early rheumatic infection. J. A. Colliver (Arch. of Pediat., Jan., 1914).

The pulse is soft and usually above 100 in rate. Evidences of toxemia, such as coated tongue, constipation, and splenic enlargement are likely to be observed.

The duration of rheumatic fever varies from some days to several weeks or even months; it is liable to

remissions and exacerbations, and, especially when the patient leaves the bed or the sick-room too soon, exacerbations are frequently observed. In some cases, the fever having declined, one or more joints remain swollen and painful for a long time. A critical decline of the temperature is rarely observed.

When the joint swellings subside the cuticle commonly cracks and peels off in small scales. As many red blood-corpuscles become destroyed during a severe attack of rheumatic fever, the patients get pale and weary. The anemia often continues for a long period after recovery from the disease itself. Leucocytosis, up to a maximum of 20,000, has been observed to develop early in the rheumatic attack and to decline with equal rapidity during convalescence.

Some authors refer to a *larval form* of rheumatic fever, characterized by neuralgia of, e.g., the trifacial or the sciatic nerve, accompanied by high fever, but without involvement of the joints, and yielding rapidly to the use of salicylates. During an epidemic of rheumatic fever endocarditis or pericarditis with high fever is sometimes observed in patients who do not suffer from any involvement of the articulations; such cases have been denominated *polyarthrits rheumatica sine arthritide*.

COMPLICATIONS.—These are very frequent and affect especially the heart and the nervous system. Verrucose and even ulcerative endocarditis is observed in a large proportion of cases, especially when the fever is high and many joints are affected. Pericarditis is not quite so frequently observed. Endocarditis

has been estimated to occur in about 20 per cent. of all cases, and pericarditis in about 14 per cent.; but these proportions vary, the epidemics of rheumatic fever differing very much in regard to severity and frequency of complications. Bosanquet, in a series of 450 cases, noted endocarditis in 28 per cent. of the males and 33 per cent. of the females, and some observers place the incidence of endocarditis at 50 to 75 per cent. The likelihood of endocarditis is increased by youth of the patient and where preceding attacks have occurred. The mitral valve is that oftenest involved. Pericarditis is observed in the majority of the cases ending fatally, and may be fibrinous, serofibrinous, or purulent.

In almost all cases some dilatation of the right heart due to **toxic myocarditis**, is found. A murmur heard over the heart is thus often not due to endocarditis, but to cardiac dilatation (or to anemia). In consequence of endocarditis, the myocardium may also be affected either by simple extension through contiguity or by emboli. A condition of complete cardiac inflammation or **pancarditis** may occur. Slight weakening of the myocardium may be manifested by general weakness, attacks of pain, or tachycardia. The symptoms of endocarditis and pericarditis are discussed elsewhere in this work.

D. B. Lees describes the cardiac complications of rheumatism in childhood as follows: The first indication of endocarditis is a systolic murmur at the apex. Often the second sound becomes doubled, after a time, the doubling being heard only in the apex region, different from the duplicated pulmonary sound of advanced

mitral stenosis. The first element of the second sound always remains sharp and short as long as it is audible at all. The second element may be substituted by a short blowing, early diastolic or middiastolic murmur. At a later stage there may be at the apex a presystolic murmur, followed by a longer and louder systolic. This presystolic murmur is blowing in character, usually short, common in children after a rheumatic attack, and generally accompanied by evidences of great dilatation of the heart. Care should be taken not to consider a soft, double sound at the base an evidence of commencing aortic disease. It is often the first indication of pericarditis.

While in adults the disease spends itself chiefly upon the joints, in the child it has a much greater tendency to attack the heart; the joint involvement in the latter is often so slight as to be overlooked, yet the cardiac involvement may be severe. Tonsillitis is in the child a frequent precursor of rheumatism, while chorea is at times a sequel. Cardiac involvement might come within 24 hours of the beginning of the rheumatic attack and its discovery depends upon a careful routine study of the heart. The mitral lesions thus caused are capable of complete recovery, though the aortic lesions practically never recover. D. Riesman (Trans. Phila. Co. Med. Soc.; Med. Rec., Apr. 16, 1921).

Rheumatism in the child can be discovered at the age of 5 years, possibly earlier. Earlier signs of the disease are an incessant restlessness, a constantly accelerated pulse rate, often reaching 100 or over, and very frequently a constant fever of a little over 99° F. (37.2° C.) to a little more than 100° F. (37.8° C.). That such a rise of temperature and of pulse rate are not due to nervous excite-

ment is proved by their being found for years in the same child and always at about the same level for any one child. This observation is based upon over 5000 temperature records. M. H. Williams (Lancet, June 19, 1915).

Very dangerous and rather frequent are the complications involving the brain. In some cases the symptoms are only caused by **hyperpyrexia**; when the temperature rises to 41° or 42° C. (105.8° or 107.6° F.) or even to 43° C. (109.4° F.), when sweating is very profuse, and signs of endocarditis develop, there is imminent danger of **cerebral rheumatism**. When symptoms of meningitis occur, they are not necessarily due to actual inflammation of the meninges, but may be caused by hemorrhage, edema, or hyperemia. A uremic condition of the blood may also lead to cerebral symptoms.

Cerebral rheumatism may manifest itself in different ways:—

1. When it is *foudroyant* the patient is suddenly seized with agitation; although previously unable to make a movement without extreme pain, he now leaves the bed and walks about, speaks and cries, and suddenly collapses and dies. The temperature ranges from 42° to 43° C. (107.6° to 109.4° F.) and often even exceeds these levels after death.

2. An *acute* form of cerebral rheumatism is more often observed. There is likewise high fever; the delirium commences more quietly, but after a little time the patient becomes agitated, and may have epileptiform seizures, these symptoms being followed by profound coma and commonly by death. In a few instances cerebral symptoms are observed with a temperature not ex-

ceeding 39° C. (102.2° F.). The pulse rate is proportionate to the fever and may reach 120 to 140 per minute. The duration of this form of cerebral rheumatism is commonly two or three days, but may be ten to twelve days. Recovery is rare.

3. The *subacute* or *chronic* form of cerebral rheumatism appears in the later stages of rheumatic fever and is ordinarily of a melancholic and stuporous character. The patients refuse to speak, even to eat, and are often harassed with hallucinations. They may remain in this condition for months, but the affection ordinarily ends in recovery.

Spinal complications have been described, but their existence has not been proved beyond doubt. The peripheral nerves may also be affected during rheumatic fever, but far oftener such disturbances occur some time later, as a sequel. **Chorea**, **multiple neuritis**, **neuralgia**, and **sciatica** have been witnessed by trustworthy observers. During an epidemic Steiner saw 35 cases with disease of the peripheral nerves—often in the distribution of a single nerve—characterized by pain and tenderness. In 8 of these, swelling of the joints was not important, though there was tenderness. Steiner claims that the nerve pains were due to a perineuritis.

Complications involving the respiratory organs are not so frequently observed. **Coryza**, **tracheobronchitis**, and **laryngitis** may be seen during the prodromal stage. During the acute stage the lungs may be affected either by **edema** or, more rarely, by **pneumonia**, particularly of the migratory form. Rather frequently the pleuræ are involved. When the pericardium is affected the disease tends

to spread to the left pleura, which consequently is more frequently attacked than the right. Rheumatic pleuritis is characterized by abundant fibrinous membranes, but scanty exudation of serous fluid; it develops very rapidly and gives rise to the ordinary physical signs of pleurisy in a very marked degree. Its duration varies from three to eight days. Sometimes the right pleura is attacked while left-sided pleuritis is undergoing resolution. Peritonitis is a rare complication which may be associated with serous pleuritis.

Tonsillitis is a frequent manifestation of the prodromal stage, and its bacteria are now considered important etiological factors in the development of rheumatic fever.

Albuminuria is almost constantly observed; acute nephritis and hematuria may occur. Anuria is a rare complication; it may be caused either by acute nephritis or by emboli from an endocarditis.

Cystitis, hydrocele, and orchitis have been mentioned by some as occasional complications.

The cutaneous complications include roseola, urticaria, erythema multiforme, herpes facialis, and, more rarely, erysipelas, gangrene, purpura with ecchymotic spots or bullæ containing a serous, bloody, or purulent fluid. Hemorrhagic complications have also been observed in the form of melena and metrorrhagia.

The muscles in the proximity of the affected joints are always painful and swollen; this may also be observed in the case of muscles more distant from the diseased joints. In rare instances true inflammation and abscesses have been observed in the muscles.

The affection of the joints themselves may be complicated by suppurative inflammation leading to opening of the articulation and to pyemia, or ending in ankylosis.

In occasional instances involvement of the eye occurs with rheumatic fever, being manifest in conjunctival congestion or, rarely, iritis. Some of the diseases of the eye ascribed to the more chronic types of rheumatism are: iritis and episcleritis—which are very frequent—as well as deep scleritis, keratitis, orbital cellulitis, optic neuritis, choroiditis, ocular palsy, glaucoma, and opacity of the vitreous (Woodruff).

Chronic nephritis and mental disease are among the possible ultimate sequelæ of rheumatic fever.

In children cardiac involvement is relatively more frequent and important than in adults and generally leads to a fatal termination, promptly or ultimately. The onset is generally abrupt, sometimes with convulsions. High fever sets in and anemia rapidly becomes pronounced. Joint involvement is comparatively a less striking feature than in adults.

DIAGNOSIS.—The diagnosis is usually easy, the migratory arthritis, fever, acid sweats, and infrequency of involvement of joints such as the sternoclavicular, temporomandibular, intervertebral, and sacroiliac being characteristic. The thyroid is often found enlarged in children, owing according to Sajous, to a defensive reaction of this organ.

Enlargement of the thyroid gland claimed to be a diagnostic sign of rheumatism in children. In some cases it preceded all other manifest signs of the disease; in others it appeared as the fourth or fifth link in the rheumatic chain, and in others

still it was found to persist along with established chronic endocarditis after all other rheumatic manifestations had disappeared. J. R. Clemens (*Arch. of Pediat.*, May, 1910).

In children the cardiac phenomena are paramount, but compression of the left lung by the pericardial exudate may cause physical signs of pneumonia in this lung to occur. The most characteristic skin lesion is the so-called rheumatic nodule, which histologically resembles the miliary nodule in the heart muscle. These are usually few, occasionally enormous in number, and are found chiefly about the elbows, backs of the wrists, near the ankles, and over the buttocks. D. Riesman (*Trans. Phila. Co. Med. Soc.*; *Med. Rec.*, Apr. 16, 1921).

Secondary Infectious Arthritis.—

Rheumatic fever may be confounded with the secondary multiple inflammations of joints observed in acute infectious diseases such as scarlatina, cerebrospinal meningitis, puerperal infection, rubeola, diphtheria, etc., and also with the pseudorheumatic affections of gonorrhea, syphilis, and tuberculosis. In all these affections the symptoms of the major disorder are present and facilitate diagnosis.

In gonococcal arthritis there is a history of gonorrhea; the joint involvement is generally monarticular, affecting especially the knee and wrist, and is extremely severe; constitutional symptoms are less marked, and the joint lesions tend to persist after the febrile stage.

In syphilitic pseudorheumatism the joint-symptoms are less intense than in rheumatic fever; are not migratory; show nocturnal exacerbation of pain, and yield rapidly to specific treatment (though pain is relieved, as it is in other forms, by the local application of methyl salicylate).

The arthritides accompanying such conditions as scarlet fever and cerebrospinal meningitis are commonly of septic type, with accompanying constitutional symptoms of sepsis.

Acute Osteomyelitis.—This condition is characterized by grave constitutional evidences of sepsis, and by especial involvement of the epiphysis and shaft of one of the bones articulating at the affected joint. The upper extremity of the tibia and the lower end of the femur are the localities most frequently affected.

Gout.—Gout may be discerned from rheumatic fever by the fact that it is never accompanied by fever of the same intensity as prevails in the latter disease; by its predilection for the great toe; by the possible presence of uratic deposits in various parts of the body, and by its special occurrence in the male sex.

ETIOLOGY.—Rheumatic fever tends to attack especially young adults, approximately three-fourths of the cases occurring between the ages of 15 and 35. Infants are almost safe, but no age is entirely exempt. The disease attains its greatest frequency between the ages of 20 and 25 years.

Both sexes are liable to the disease; among adults, men are perhaps somewhat more frequently affected than women, but that is probably on account of their greater exposure to the inclemency of the weather. Between the ages of 10 and 15 the disease is somewhat more common in the female than the male sex. An hereditary predisposition seems to exist in some families. Cheadle, among 32 consecutive cases, found evidence of heredity in 70 per cent., and, if chorea and erythema be re-

garded as forms of rheumatism, in 93 per cent.

Exposure to wet, cold, and abrupt temperature changes predisposes to rheumatic fever, which is therefore commonest in coachmen, laborers, sailors, and, among women, in washerwomen and domestics. The disease is frequent only in temperate climates, and is not observed in tropics or in the arctic regions.

The exciting cause of the disease is now considered to be unquestionably an infection. This view is supported by the facts that it occurs epidemically, as well as endemically, and that during epidemics the cases accumulate in some houses, whereas other houses are quite spared. Meteorological conditions do not appear to be of great influence on the epidemics of rheumatic fever, which have been observed as well in the summer as in winter, during dry as well as wet seasons. The epidemics vary greatly in intensity and duration, and occur at irregular intervals.

It is still doubtful whether rheumatic fever is the product of one specific micro-organism or whether different species act simultaneously or independently as pathogenic factors. At all events, the clinical and pathological features of the disease clearly show its infectious origin. That streptococci may produce it has been shown by a number of observers, who have not only recovered these organisms from the blood and joints of patients, but, like Schloss and Foster, reproduced lesions suggestive of rheumatic fever in lower animals. The organism considered to be most likely the actual exciting factor, or at least that operative in the largest proportion of cases, is the

Diplococcus rheumaticus isolated by Poynton and Paine, who found it not only in the joints and blood, but in rheumatic nodules and the urine, and with it produced arthritis, valvular lesions, etc., in rabbits. This organism is distinguishable neither morphologically, culturally, nor by the opsonic and agglutinin reactions (Tunncliffe) from the *Streptococcus pyogenes*, but only by the production of rheumatic lesions in animals. Poynton and Paine consider their diplococcus the "only bacterial cause" of acute rheumatism. Cole believes it unwarranted, however, to recognize a distinct variety of streptococcus because of its property of producing arthritis and endocarditis, as he has provoked similar lesions in animals with streptococci from various sources. This is in accord with the present increasing disinclination of bacteriologists to believe that sharp lines separate similar organisms into distinct varieties, and is supported by the observations of Rosenow (1914) that the affinity of cocci freshly isolated from the joints in rheumatism for the articulations, endocardium, and often also myocardium and voluntary muscles, which tends to disappear on cultivation, may be restored by passage through animals, and that other strains of streptococci under certain conditions may be made to acquire the properties of the strains obtained from rheumatic cases.

Five cases have been published to date in which the tuberculous nature of an articular rheumatism has been established beyond question. The writer's patient was a girl of 19 who had had glandular tuberculosis as a child, and later a tuberculous process in the lower jaw compelling total re-

section. Twelve days after the operation, moderate fever developed with multiple acute swelling of joints. The patient died in a few months from amyloids. Autopsy showed tuberculous nodules in the synovial membranes. Melchior (Mittel. a. d. Grenz. d. Med. u. Chir., xxii, No. 3, 1911).

Cultures of exudate aspirated from the joints in acute rheumatic arthritis proved uniformly sterile. Non-hemolytic streptococci were recovered in blood cultures from less than 10 per cent. of rheumatic fever patients. Similar streptococci were recovered from active endocardial lesions in only half of the fatal cases. No type of streptococcus is constantly associated with acute rheumatic fever. If the streptococcus actually is the etiologic agent, the infection occurs through various members of the viridans group. Swift and Kinsella (Arch. of Int. Med., Mar., 1917).

Report of an acute case in a girl of 17, with a heart injured by a previous attack. A general pericarditis with copious effusion developed, and the fluid withdrawn by paracentesis showed numerous minute diplococci, some in the fluid, many more in leukocytes. This completely supports the results of experimentation concerning the micro-organism of rheumatic fever. It also indicates that in human rheumatic pericarditis with little effusion but with great thickening of pericardial tissues, the diplococci are shut in the necrotic areas but imperfectly destroyed, causing the intractable relapsing cases of childhood. Poynton (Brit. Med. Jour., Mar. 29, 1919).

As for the portals of entry of rheumatic infection, the tonsils demonstrably play an important, if not exclusive, rôle in this direction. Not only are the tonsils favorite abodes of virulent streptococci, and attacks of sore throat a frequent manifestation of rheumatism, but organisms isolated from the tonsils of rheumatic cases have, with considerable con-

stancy, been observed to induce arthritis and endocarditis when injected into animals. Permanent cure of a rheumatic tendency has frequently followed removal of the tonsils. According to some, the gums, the nasal mucosa, and the gastrointestinal tract are also at times sources of infection.

The pleurisy of acute rheumatism usually yields promptly to the salicylates, but if it is left untreated, serious lesions may be installed. The rapid invasion of the pleura, the bilateral involvement, the association with congestion of the lungs and with pericarditis without effusion, the complete subsidence without sequels, the fixity and long duration of the pleural effusion, its moderate amount, and the usually mild character of the pains in the chest are its distinguishing features. J. Mollard and M. Favre (Lyon méd., May, 1917).

Peritonitis, appendicitis, bronchitis, and pneumonia are sometimes ascribable to rheumatic infection.

Micrococcus rheumaticus takes the path of least resistance. This may be an unhealthy throat, absorption from which frequently gives rise to general rheumatic infection, including peritonitis and appendicitis, directly through the vascular system. Or it may be localized in the bronchial tubes and give rise to pneumonia, with polyarthritis and endocarditis. An unhealthy condition of the intestinal wall may excite to activity the rheumatic agent. Congestion of the pharynx, palate, and fauces in a child with a rheumatic family or previous history, or with a rheumatic facies, should always be looked on seriously, and met with local applications of salicylic acid preparations, together with sodium bicarbonate, sodium salicylate, potassium chlorate, and aperients. A 5 per cent. to 10 per cent. solution of sodium salicylate applied to the tonsils, palate, and pharynx protects from further contamination; a gargle containing 20 to 40 grains

(1.3 to 2.6 Gm.) to the ounce (30 c.c.) is equally efficacious. Decayed teeth should be filled or extracted, and the daily use of the tooth-brush and antiseptic powder should be insisted on. Inhalation for half an hour, three times a day, of 10 minims (0.6 c.c.) of a solution of equal parts of **creosote** and **phenol** is the best method of protecting the pulmonary mucous membrane. **Sodium salicylate**, combined with **sodium bicarbonate** and **rhubarb** powder, is by far the best protective treatment in cases in which there is any indication of excess of mucus in the intestine. J. K. Mackenzie (Brit. Med. Jour., June 1, 1912).

A woman of 28 developed subacute articular rheumatism and endocarditis five months after an infected abortion. No benefit was procured from a month or more of the ordinary measures, including the salicylates, but after **straightening** and **curetting** the **uterus** the temperature dropped to normal and rapid recovery followed, signs of mild mitral insufficiency, however, still persisting. Articular rheumatism of puerperal origin generally settles down in one joint after a time—the shoulder in the writer's case—and stays there. Pierra (*Revue mens. de gynéc., d'obstét., et de pédiat.*, Mar., 1914).

PATHOLOGY.—In all cases of rheumatic fever hyperemia is present in the joints; but as these changes are extremely fugacious it is ordinarily impossible to demonstrate them at autopsy. In more advanced cases the synovia is augmented and shows microscopically a great number of polynuclear cells containing globules of fat, resembling pus-cells. In some cases the cells are not free, but are inclosed in a network of fibrin, appearing to the naked eye as small flakes. True pus is not found in the joints except when other infections have invaded the body consentane-

ously with the specific infection of rheumatic fever. The synovial membrane of the affected joints is then red and swollen, with its capillaries engorged with blood; the cells of the synovial membrane tend toward multiplication, containing 10 to 12 nuclei. The cartilage is also involved; its cells multiply and form oblong capsules containing many secondary capsules. The macroscopic result of these alterations is that the cartilage has lost its natural polish and that it is finely striated. These pathological changes are common to all varieties of acute arthritis and are not characteristic of rheumatic joint affection. Mainly because of periarticular involvement, some of the rheumatic joints, instead of promptly recovering from the acute process, may continue in a condition of subacute or chronic inflammation. The tendons and even the periosteum may be attacked, with consequent tender local thickenings.

The rheumatic alterations of the endocardium, the pericardium, etc., revealed by autopsy present the ordinary signs of an acute inflammation, but nothing which is characteristic of rheumatic fever proper. Acute dilatation of the heart, according to Lees, is much commoner, even in slight attacks, than in diphtheria or influenza. It is, however, far less dangerous. Although in the rheumatic heart there is evidence of fatty degeneration of the muscle fibers, with interstitial round-cell foci, the destruction of the muscle is much less pronounced than in the diphtherial heart.

Children are prone to the chronic or subacute manifestations of rheumatism because the chief site of the

multiplication of the organism and the manufacture of the toxins is in focal lesions outside the bloodstream, while in adults it is in the blood itself. The rheumatic nodules afford the typical example of local response to rheumatic infection. They are usually associated with grave cardiac mischief, and the more numerous and the larger they are the more serious the cardiac involvement. While present, they prove the persistence of the rheumatic infection. The lesions found in the heart are similar in structure to the subcutaneous nodules, but their duration is probably less prolonged. In the mesocardium they are found chiefly in the walls of the left ventricle, especially near the mitral and aortic valves. In pericarditis the nodular lesions may be confined to a small area or scattered all over the pericardium. In endocarditis the nodules are subendothelial, and are situated mostly at the upper part of the left ventricle, especially in the mitral valve. Gosage (*Pediatrics*, Apr., 1912).

Greater attention should be given to the various types of acute aneurisms and their relations to acute rheumatic fever. The almost constant presence of some inflammatory reaction in the ascending limb of the aorta should be recognized as an associated condition in this disease. Klotz (*Jour. of Pathology and Bacteriology*, Oct., 1913).

During the course of rheumatic fever the blood contains much more fibrin than normal.

PROGNOSIS.—The prognosis is rather good as regards life, as very few cases end fatally (0.3 per cent.). Usually the disease terminates in two to six weeks without having caused permanent injury to the joints involved. Complications, particularly those involving the heart, are, however, frequent and often lead to serious consequences. In some cases—subacute rheumatic fever—repeated

exacerbations in the joint lesions and temperature occur before recovery finally is complete. Hyperpyrexia and suppurative pericarditis are complications entailing immediate danger, while endocarditis acts more slowly. In children the remote prognosis is always grave, death taking place in youth or early adult life. The gravid state also renders the condition more serious. One attack of rheumatic fever predisposes to others, and the ultimate prognosis becomes more somber in proportion with the persistence of recurrence.

Twenty-three per cent. of acute articular rheumatism patients go through one or more attacks without any clinical affection of the heart, irrespective of the age when first attacked; 22 per cent. develop signs of carditis in the acute stage, these signs disappearing during the convalescence; 18 to 20 per cent. of the cases which develop signs of endocarditis, not clearing up before patient leaves the hospital, have no permanent valvular lesion, the murmurs being due to myocarditis, or incompetence from temporary hyperemia of the valves, associated with dilatation. In 14.5 per cent. of cases with acute rheumatic endocarditis of severe type, one or more of the murmurs disappear, such murmurs being due to associated dilatation. Cases in which the heart is going to recover completely show signs of such recovery within twelve months of the acute attack, though the process may not be completed till some years later. Kemp (*Quarterly Jour. of Med.*, Apr., 1914).

Analysis of 350 fatal cases of rheumatism. The patients comprised 195 females, 155 males, 250 of them under the age of 12 years. Rheumatism is at its worst from the sixth to the twelfth year, and the majority of deaths occur before the twentieth year. The percentage of fatal first

attacks in childhood was nearly 23 per cent. In the remaining 100 cases only 3 deaths were recorded in a first attack. Pericarditis was found in 215 of the 250 cases in childhood. One may expect to detect the friction sound in at least 80 per cent. of the cases of recent rheumatic pericarditis; it may be missed because the pericarditis is localized posteriorly, very limited in area, or evanescent. In the 250 fatal cases in childhood, the mitral valve was damaged in all but 3, the aortic in 102, the tricuspid in 78, the pulmonary in 6. Among 100 cases in children, 82 died with evidence of acute carditis. Among 100 older cases, only 9 died of acute carditis of the childhood type; 14 had recent endocarditis complicating former valvular lesions; in 55 the valves were scarred by old disease, and 22 died of malignant endocarditis. The usual time for malignant endocarditis is later childhood, adolescence, and early adult life. Death from myocardial failure without valvular lesion occurred in only 3 of the 350 cases. F. J. Poynton, C. D. S. Agassiz, and J. Taylor (*Pract.*, Oct., 1914).

TREATMENT.—In the treatment of rheumatic fever it is of importance that the patient be placed in a large, well-ventilated room. He should be kept in bed, even where the affection is mild. A flannel nightgown should be worn, and the patient should sleep between blankets. The diet should be limited; during the febrile period liquid food should alone be given, with lemonade, carbonated waters, and milk as beverages. Regularity of the bowel movements should be maintained.

Many authors deem it preferable to commence the treatment by instituting free purgation.

As a specific remedy against the infection itself, **salicylic acid** and combinations containing this drug have nearly supplanted all others.

Salicylic acid may either be given pure or in combination with the alkalies (**sodium** or **strontium salicylate**). Pure salicylic acid is best tolerated when given in capsules each containing $7\frac{1}{2}$ to 15 grains (0.5 to 1 Gm.); this dose is to be repeated four, five, or even six times per day, until the pain is relieved and the temperature falls. When symptoms of intoxication, viz., ringing in the ears, nausea, or occasionally, delirium appear the use of the remedy must be discontinued for twelve to eighteen hours, or the dose greatly reduced. In many cases the pain is very rapidly subdued by this treatment and patients who, in the morning were not able to move, are completely relieved after a treatment of twelve hours. In other cases the fever subsides, but the pain and swelling of one or more joints continue for some time. Even when all symptoms have disappeared, it is advisable to continue the use of salicylic acid for some time, but in lesser dose. When the use of salicylic acid is discontinued too soon, recurrence is probable.

Many authors prefer the use of **sodium salicylate** which is sometimes given in solution, 1 to $1\frac{1}{2}$ drams (4 to 6 Gm.) or even 2 drams (8 Gm.) being administered per diem. It has the same effect on the disease as the pure acid. By the third day the dose can generally be reduced to 15 grains (1 Gm.) every four or five hours. Other compounds which may be used are **ammonium salicylate**, **salicin**, and in particular, **acetylsalicylic acid** (aspirin) which, being nearly tasteless, is easily taken with sugar and water on a spoon or in milk, and is non-irritating to the stomach, passing through it unaltered into the in-

testine, where it is decomposed and absorbed in the form of salicylic acid.

Inflammation of the throat emphasized as one of the earliest symptoms of rheumatism and a gargle of 20 Gm. (5 drams) of **sodium salicylate** in 1000 Gm. (1 quart) of distilled water recommended. In the developed disease one should endeavor to administer from 6 to 8 Gm. (1½ to 2 drams) in twenty-four hours to the adult; in children 1 Gm. (15 grains) per diem if the child is 2 years of age or less, and 2 Gm. (30 grains) if 4 or 5. If the drug is not well borne in such large doses, these must be decreased 5, 4, or 3 Gm. (1¼, 1, or ¾ drams) until tolerance is produced. It should not be given if nephritis with the presence of casts in the urine exists, but if the albuminuria is slight and there are no casts it may be given with caution.

When the myocardium shows signs of being affected, and the pulse irregular, care must be taken not to depress the heart further. If the endocardium or pericardium are implicated, the salicylate may be given, but it must be withdrawn where there is delirium and other signs of cerebral excitement. In pregnancy it must be given with caution. **Aspirin** is less efficacious than the salicylates, and should be given in divided doses up to 1 to 3 Gm. (15 to 45 grains) per day, according to age; **pyramidon** (0.50 to 1.50 Gm.—7½ to 23 grains) also has its uses. If these remedies in succession do not produce improvement, they can be combined with advantage: **Sodium salicylate**, 0.25 Gm. (4 grains); **aspirin**, 0.15 Gm. (2¼ grains); **pyramidon**, 0.15 Gm. (2¼ grains). In cases complicated with nephritis, cupping of the loins, **milk diet**, and **laxatives** are indicated. Lemoine (Gaz. des pract., vol. xix, 1912).

The commonest avenue of rheumatic infection is the tonsil, and next to it the nose. The first essential of rational treatment of rheumatic infection is restoration of the upper air

passages to a healthy condition. Irrigation and thorough cleansing of the nasal passages, combined with antiseptic treatment of the nose and pharynx, should be a routine item of antirheumatic treatment; and the operation of **enucleation** should be performed without delay upon all rheumatic children who exhibit chronic enlargement of the tonsils or of the tonsillar lymphatic glands. W. P. S. Branson (Brit. Med. Jour., Nov. 23, 1912).

The writer recommends daily injections of from 1 to 2 Gm. (15 to 30 grains) of sodium salicylate. The solution is made as follows:—

<i>Sodium salicylate</i>	5.0 parts.
<i>Caffeine citrate</i>	0.25 part.
<i>Distilled water</i>	25.0 parts.

Of which from 6 to 10 c.c. (1½ to 2½ drams) are given daily. The salicylate must be chemically pure and the solution kept in the dark. It is of special value where medication by mouth is not well borne. P. V. Cernadas (Semana Medica, Dec. 23, 1915).

The writer recommends the administration of the **salicylates** by rectum or intravenously where the stomach is rebellious or the case requires rapid action. The intravenous injections are of 10 to 20 grains (0.6 to 1.3 Gm.) in 20 per cent. solution and given two or three times in twenty-four hours if necessary. Rectal injections are preferred, and as much as 2 drams (8 c.c.) may be given, with 15 minims (1 c.c.) of **tincture of opium**, repeated in twelve hours. The alkaline treatment may be combined with this, and **salicin** in 10- to 20-grain (0.6 to 1.3 Gm.) doses may be given every two hours when pain in the joints has diminished. The best combination internally is **ammonium salicylate**, 5 to 10 grains (0.3 to 0.6 Gm.), with **phenacetin**, 1 to 2 grains (0.06 to 0.13 Gm.), and **caffeine citrate**, 1 grain (0.06 Gm.) in capsules, every two hours. Beverley Robinson (Med. Rec., Jan. 1, 1916).

The first essential is the thorough searching out and removal of all foci of chronic infection and the preparation of an **autogenous vaccine** from organisms isolated from such foci or from the urine if foci cannot be definitely located. The vaccines should be given in ascending doses, every week or ten days, adjusting the dose so as to secure a slight arthritic reaction. After improvement has advanced, the intervals between doses may be lengthened. The treatment should be continued for a year or more. M. J. Rowlands (Lancet, Jan. 15, 1916).

Also serviceable where the simple salicylates are not well borne is **salophen**, which is gradually decomposed in the bowel into salicylic acid and acetylparamidophenol, and may be given in doses of 15 grains (1 Gm.) every three hours, preferably in conjunction with **sodium bicarbonate**, 10 grains (0.6 Gm.) three times a day (W. H. Flint). This drug has also been recommended for use late in the course of the disease, when the acute fever has been mastered with salicylic acid. **Oil of wintergreen** may also be substituted for the other salicylates in doses of 20 minims (1.25 c.c.), but is not unirritating to the stomach.

Salicin has a bitter taste, is much less nauseous than sodium salicylate, and can be conveniently given dissolved in hot water. It only yields 43 per cent. of its weight of salicylic acid, and hence the amount required is at least double that of sodium salicylate—20 to 30 grains (1.3 to 2 Gm.) every hour or two hours until 1 ounce (30 Gm.) has been given, and then smaller doses according to the circumstances. **Acetylsalicylic acid** is very active and has a marked analgesic effect. It cannot be prescribed with alkalis, which decompose it, and hence it is apt to bring on nausea and vomiting if given continuously. **Methyl salicylate** is also very apt to

irritate the gastric mucous membrane, but in 10- to 20-minim (0.6 to 1.25 c.c.) doses up to 60 or 90 minims (3.75 to 5.6 c.c.) per day, given in emulsion, or on sugar, or in milk, it acts powerfully, and externally applied it is unrivalled for its analgesic action. **Sodium benzoate** has the same specific effect as the salicylate, but acts less powerfully. On the other hand, it is practically non-poisonous and has no disturbing side-effects. It can be given in 20-grain (1.3 Gm.) doses every two or three hours with satisfactory results in cases of uncomplicated rheumatic fever, but its practical usefulness is merely as a substitute for the more powerful salicylate, when the latter cannot be tolerated. Profuse perspirations and skin eruptions are inconveniences which frequently follow salicylates. They are also often deemed to act as heart depressants, but this is not borne out by exact observations. With large doses (250 to 400 grains—17 to 27 Gm.—per day), such as are sometimes given with the idea of thoroughly destroying the infective germ, vomiting frequently occurs, and it is possible not only to seriously depress the nervous system, but to bring on a dangerous condition of acidosis. This can be prevented, to some extent at least, by giving about twice the amount of **sodium bicarbonate** with each dose of **sodium salicylate**, and taking care at the same time to avoid constipation. But in an ordinary case of moderate severity 15 to 20 grains (1 to 1.3 Gm.) of sodium salicylate every three or four hours form a sufficient dose. The joint pain and temperature begin at once to be favorably affected, the former subsiding in from twelve to twenty-four hours, and the latter within forty-eight hours. The pulse and respiration fall with the temperature, and the joint effusion is absorbed in two or three days. The course of events usually resembles a crisis, though sometimes a lysis. If the temperature does not settle satisfactorily each dose may be

increased, or one large additional dose of 40 to 60 grains (2.6 to 3 Gm.) may be given on one or on several days in succession. Additional absorption of salicylic acid may be brought about by applying a dressing of **methyl salicylate** on lint to the affected joints. Where the rheumatic infection locates itself chiefly in the fibrous tissues, the condition generally in time yields to large doses of salicylates, along with free local application of **methyl salicylate**. When these rheumatic indurations are quite recent, **potassium iodide** and small blisters exert a marked deobstruent effect. **Massage** is even more effectual. Stockman (Pract., Jan., 1912).

The writer nearly always used **aspirin** and **sodium salicylate** jointly, administering as much as 10 or 15 grains (0.6 to 1 Gm.) of **sodium salicylate** and 5 to 10 grains (0.3 to 0.6 Gm.) of **aspirin** every two hours alternately. W. J. Judy (W. Va. Med. Jour., Aug., 1912).

Sodium salicylate with **sodium bicarbonate**, 1 part of the former with 2 parts of the latter, is a most effective antirheumatic, if the dose is gradually increased to a sufficient extent. If, when vomiting or tinnitus occurs, the medicine is suspended for a few hours, the unpleasant symptoms will usually pass away, and the dose can later be raised to a considerably larger amount without causing their recurrence. In a rheumatic attack it is often desirable to increase the amount of salicylate to 150 or 200 grains (10 to 13 Gm.) per day, with double the amount of sodium bicarbonate, given in 10 doses. It is important to prevent constipation, to keep the urine slightly alkaline and to stop the drug when vomiting or other symptoms due to salicylate occur. Lees (Brit. Med. Jour., Oct. 12, 1912).

The nodes call for intensification of the treatment. In 1 of 3 cases in children of 11 and 13, **salicylates intravenously** and by the mouth were kept up for 7 months with slow im-

provement and final recovery, even the heart functioning normally and the child increasing 22 pounds in weight. The nodes, though extremely numerous, persisted for 3 months. A girl of 11 years was given orally in 4 months 130 Gm. (4½ ounces) of the salicylate besides intravenous injections up to a total of 9.5 Gm. (2¼ drams). Though the treatment was ordered discontinued, the parents continued it for 3 months longer (32 injections by the vein) with a total of 16 Gm. (4 drams), perfect recovery resulting. Navarro (Rev. de la Asoc. Med. Argentina, Apr.-June, 1920).

Nothing certain is known of the manner in which salicylic acid and its compounds influence the rheumatic infection. Possibly salicylic acid has a specific action on the micro-organisms; it is a reliable, but not an infallible, remedy, relieving the joint condition, shortening the disease, diminishing the likelihood of relapse, and probably protecting the heart. Some cases are rebellious to its action. Some patients do not tolerate it, vomiting being induced. It may then be administered by inunction or enema. For inunction a 20 per cent. ointment of **salicylic acid** or of **methyl salicylate** may be used. For administration by enema Erlanger uses the following formula:—

℞ *Sodii salicylatis*. 3iiss to ij (6 to 8 Gm.).
Tinctura opii .. ʒlxxv (5 c.c.).
Aqua fʒiiiss (100 c.c.).—M.

This should be injected, after preliminary cleansing of the bowels, at body temperature, and should be retained as long as possible in the intestines.

Intrarectal administration of **sodium salicylate** recommended in refractory cases of acute and subacute rheumatism. The salicylate enema is given immediately after a cleansing soapsuds enema, and is administered with a

Davidson syringe and a rectal tube inserted 6 to 8 inches. First dose in men is usually 8 to 10 Gm. (2 to 2½ drams), in women 6 Gm. (1½ drams), incorporated in 120 to 180 c.c. (4 to 6 ounces) of plain or starch water, with 1 to 1.5 c.c. (16 to 24 minims) of opium tincture. The dose may be repeated within 12 hours, but usually a daily enema suffices, with doses increasing from 30 to 50 per cent. daily until the limit of tolerance is reached. L. G. Heyn (Jour. Amer. Med. Assoc., Sept. 19, 1914).

Where the effects of salicylates in acute rheumatism are not as expected, the so-called "alkaline treatment" may be instituted, or, the two forms of treatment may be combined—a procedure especially useful in children. This consists in the administration of 20 or 30 grains (1.25 or 2 Gm.) of **potassium bicarbonate, citrate, or acetate, or sodium bicarbonate** every two or three hours for the first few days, or until the urine is alkaline. Luff advises combined salicylic and alkaline medication in all cases of rheumatic fever. He gives 20 grains (1.25 Gm.) of sodium salicylate and 30 grains (2 Gm.) of potassium bicarbonate every two hours until pain is relieved, then every four hours till the temperature has fallen to normal. Fifteen grains (1 Gm.) of the salicylate and 20 grains (1.25 Gm.) of the bicarbonate are then given every four hours until all joint symptoms have disappeared, and after this three or four times a day for a fortnight longer.

Comparative statistics show that patients do not recover any more quickly under **salicylates** than with the **alkaline treatment**, but with the salicylate treatment pain is sooner relieved. Heart complications are not any more common when treating with the salicylates. J. L. Miller (New York Med. Jour., July 4, 1914).

Intravenous and subcutaneous injections of salicylates have been recommended by several observers, both to avoid upsetting the stomach and for prompt, powerful effect. Behr lauds the following combination for intravenous use, originated by Mendel:—

R Sodii salicylatis ... ʒij (8 Gm.).

Caffeina sodiosalicylatis (N. F.)... ʒss (2 Gm.).

Aqua sterilis, q. s. ad ℥iiss (50 c.c.).—S.

Methyl salicylate, or artificial oil of wintergreen, is recommended for external use in rheumatic fever. It is a volatile fluid of an aromatic odor. The affected joints are to be painted with the drug and enveloped with some impervious material. Experience has shown that the salicylic acid contained in methyl salicylate is absorbed through the skin. It is also chemically demonstrable in the urine. It removes the pain and reduces the temperature.

In acute rheumatism and allied conditions such as acute rheumatic sciatica, the result of **thyroid** treatment may be striking. Tompkins (So. Med. Jour., Dec., 1910).

Hypodermic injection of salicylates advocated, for the purpose of securing prompt action and avoiding digestive disturbances and toxic symptoms. In acute rheumatic infection of joints, heart, pericardium, pleura, and central nervous system (chorea), inject 10 c.c. (2½ drams) of 20 per cent. sterile solution of fresh **sodium salicylate** per 100 pounds of body weight. First disinfect a spot outside of the median line of the thigh with fresh iodine tincture. Through this inject sterile **cocaine solution** (¼ grain—0.008 Gm.—in 30 drops) under the skin, and after waiting fully fifteen minutes inject salicylate solution under the same spot. This causes general improvement within three hours. Repeat the injection every twelve hours. In severe cases, with many seats of involvement, increase

the dose to 15 c.c. ($\frac{1}{2}$ ounce) per 100 pounds weight. In chronic cases, inject every twenty-four hours 10 c.c. ($2\frac{1}{2}$ drams) per 100 pounds of the following: **Salicylic acid**, 10 Gm. ($2\frac{1}{2}$ drams); **sesame oil**, 80 Gm. ($2\frac{3}{4}$ ounces); **pure alcohol**, 5 Gm. (75 drams); **gum camphor**, 5 Gm. (75 grains). This is to be sterilized before adding the alcohol, and afterward excluded from contact with air, to avoid evaporation of alcohol. The effect of the injection in chronic cases is obtained more rapidly when multiple localizations of the rheumatic process are present than when one joint is affected. In the former, pain and stiffness usually improve after the first injection; in the latter, after the third. The addition of camphor (from 5 to 20 per cent.) was found beneficial in stimulating the heart when the pericardium or the endocardium was involved. Seibert (Med. Rec., Mar. 11, 1911).

Magnesium sulphate, administered by intramuscular injection, by mouth, and applied externally, found valuable in cases of acute articular rheumatism. Intramuscular injections of 4 c.c. (1 dram) of a sterilized 25 per cent. solution of the salt, all aseptic precautions being observed, brought rapid relief from pain, reduced stiffness and swelling, and sometimes considerably lowered temperature. No pain followed the injections. In some instances purgation resulted. Injections were repeated on succeeding or alternate days. A saturated solution was applied to the inflamed joints with benefit. The intramuscular injections are recommended for cases in which salicylates fail to give results. A. B. Jackson (N. Y. Med. Jour., June 24, 1911).

In many cases where the salicylates failed in their action, or were not well borne, **collargol** in the form of an intravenous injection, 2 c.c. (32 minims) of a 5 per cent. solution, or an enema of 50 c.c. (1 $\frac{1}{2}$ ounces) of a 5 per cent. solution, gave excellent results. In giving the intravenous in-

jection the heart must be normal, as there is a sudden rise of temperature to 40° C. (104° F.); the injection per rectum is not followed by this rise in temperature, and the results are about the same. Junghaus (Deut. med. Woch., Nov. 1, 1912).

Case of rheumatic fever in which, although sodium salicylate appeared at first to be giving excellent results, the pain, joint swelling, and fever later returned, the heart rate increased, and the first sound became muffled. Ten days' energetic treatment with the salicylate proving completely ineffectual, 8 Gm. (2 drams) of **antipyrin** were administered in two days, and the **salicylate** in daily doses of 5 Gm. (75 grains) resumed immediately after. The fever was thus rapidly overcome and convalescence entered upon. The return to a massive dose of the salicylate after the two days' intermission seemed the essential factor in the benefit obtained. Interrupted administration of salicylates has already been recommended for obstinate cases, and antipyrin seems especially suitable for use during the intervals. Roch (Rev. méd. de la Suisse romande, Feb., 1913).

The writer's experience with the intravenous administration of **sodium salicylate** comprises 12 cases of articular rheumatism of various degrees of severity, in which about 130 injections were used. The two most important points to be observed in the giving of the injections were found to be: (1) to use only a very fine, sharp needle, so that the trauma to the vein wall may be as slight as possible; and (2) to have the solution fresh and made with chemically pure, crystalline sodium salicylate. The stock solution was made by dissolving 10 Gm. ($2\frac{1}{2}$ drams) of C. P. crystalline sodium salicylate in 50 c.c. (1 $\frac{1}{2}$ ounces) of distilled water, freshly sterilized by boiling. The drug was weighed and handled as aseptically as possible and the solution, after being made, not subjected to further sterilization. The solution should be per-

fectly colorless and, if protected from the light, was found to keep for several days. L. A. Conner (Med. Rec., Feb. 21, 1914).

Attention to the joints in rheumatic fever is of great importance. They should be placed at complete rest by means of **splints**, and may also with advantage be wrapped in cotton or in cloths wet with a saturated solution of **magnesium sulphate** or with **lead water** and **laudanum**. **Methyl salicylate**, as already mentioned, may also be applied.

Bourget recommends the following ointment:—

R *Acidi salicylici* gr. xlv (3 Gm.).
Olei terchinthina ... m̄xlv (3 c.c.).
Adipis lanae hydrosi,
Adipis benzoinati...ãã 3v (20 Gm.).

Fiant unguentum.

Sig.: To be applied, and covered with absorbent cotton and an impervious material.

Baker finds the following collodion useful in relieving pain:—

R *Phenylis salicylatis* 3j (4 Gm.).
Aetheris f3i (4 c.c.).
Collodii f3j (30 c.c.).

M. Sig.: To be painted on the affected joints twice daily or oftener.

Arendt praises a formula containing **ichthyol**:—

R *Ichthyolis* 3iiss (10 Gm.).
Alcoholis diluti f3iiss (10 c.c.).
Aqua destillata f3x (40 c.c.).—M.

Robinson has found the following ointment so efficient as to permit of dispensing with internal treatment altogether:—

R *Mentholis* 3j (4 Gm.).
Methylis salicylatis f3j (4 c.c.).
Acidi salicylici 3ij (8 Gm.).
Alcoholis q. s. ad f3j (30 c.c.).

M. Sig.: Paint joints briskly with camel's-hair brush, cover with absorbent cotton and oiled silk, and bandage snugly but not tightly.

When the epidermis begins to peel an emollient ointment should be substituted for a day or two.

Sixteen cases of acute rheumatism treated by **typhoid vaccine**, used only as a standardized foreign protein. Sixteen minims (1 c.c.) were given intravenously daily until a cure had been obtained. The treatment is justifiable where apical abscesses, infected tonsils, gall-bladder, appendix, or genitourinary tract can be demonstrated and removed, and in those refractory to other treatment. Lyter (Jour. Amer. Med. Assoc., Jan. 5, 1918).

Excellent results from hypodermic injections, once daily, of 150 c.c. (5 ounces) of a solution of 7 Gm. (108 grains) of **sodium chloride** and 10 Gm. (155 grains) of **sodium sulphate** in a liter (18 ounces) of water. It is seldom necessary to give more than 3 or 4 doses to obtain marked improvement. S. L. Brian (La Semana Med., June 6, 1918).

Subcutaneous injection of oxygen systematically used in thousands of patients with rheumatism, mostly subacute and chronic. It is a powerful adjuvant to other measures. The writer usually injects 100 c.c. (3¼ ounces) at the site of the pain, sometimes injecting all the larger joints at 1 sitting, using up 2, 4, or more liters. An elderly woman with chronic nodular rheumatism for two years in hands and knees was relieved of all pain and inflammation by 8 injections. The oxygen was injected into the dorsum of the hands and massaged into the fingers. Zabaleta (Siglo medico, Aug. 10, 1918).

In subacute and chronic rheumatism several writers advise the use of a 33 per cent. **ichthyol** ointment or a 20 per cent. **ichthyol-glycerin solution**, aided by **ichthyol** and **iodides** internally. **Salicylic cataphoresis** has also been used.

Report of rapid cure of acute rheumatism after intra-articular injections of **sodium salicylate** by the **cataphoretic** method. Similar cases reported.

Wuliyamoz (Brit. Med. Jour., Aug. 13, 1910).

Occasionally cases of rheumatism are met with in which the pains do not yield to sodium salicylate and yet promptly yield to **acetylsalicylic acid (aspirin)**. Internal administration of salicylates frequently fails to give relief to the pain experienced about the fibrous tissues, notably under the heels in patients who have had a previous attack of acute articular rheumatism. In such cases the local use of **oil of wintergreen**, 1 dram (4 Gm.) to an ounce (30 Gm.) of lanolin, will generally give relief. The same applies to the pain accompanying acute rheumatic pleurisy or pericarditis. For painful conditions about fibrous structures the addition of from 3 to 5 grains (0.2 to 0.3 Gm.) of **potassium iodide** to the **sodium salicylate** often proves beneficial. Joint effusions of rheumatism are responsive to salicylates in proportion to the absence of mechanical irritation by movement. In erythema nodosum local treatment with **oil of wintergreen** brings marked relief of the pain and probably a shortened duration of the attack. A. F. Voelcker (Clin. Jour., Aug. 16, 1911).

The writer recommends in the treatment of light attacks of rheumatism, as well as in sciatica, gout, and neuralgias in general, the following:—
Acidi salicylici 10 Gm. (2½ dr.).
Olei terebinthinae ... 50 Cc. (1½ oz.).
Sulphuris praecipitati, 40 Gm. (1½ oz.).
M. ft. lotio.

The salicylic acid is dissolved in 10 Gm. (2½ drams) of the turpentine, the sulphur mixed with the remainder, and the two portions then mixed. After the preparation has been applied to the skin, it is covered with a layer of impermeable tissue held by a bandage. When the dressing has been allowed to remain for three or four days the skin, on its removal, will be found to have become detached from the deeper layers. Unless the patient is sensitive, the preparation may be applied again.

Otherwise, it is well to use a **zinc paste**. Scharff (Therap. Monats., Feb., 1912).

Excellent results obtained by applying externally a mixture of 2 parts of ground **camphor** and 1 part of **phenol**, adding 5 per cent. **alcohol** to the mixture. The result is an oily fluid, sparingly soluble in water, and free from caustic action. Only very delicate skins feel a slight smarting. It seems to be especially toxic to streptococci. V. Chlumsky (Zentralbl. f. inn. Med., Mar. 9, 1912).

In children the salicylates, also hold first place. The dose must be 90 to 150 grains (5.8 to 9.7 Gm.) in divided doses at short intervals during the first 24 hours, with a nearly equal amount of **sodium bicarbonate**. Later the dose may be lessened. If the case responds at all the fever and pain subsides in 48 hours. In some cases **morphine** must be given. The joints may be wrapped in cotton or local applications of **lead water** and **laudanum**, **magnesium sulphate** or **oil of gaultheria** made. A splint may be applied. Abundance of **water**, **lemonade** and **orangeade** should be given. The food should be in the form of **milk** or **milk products**, **cereals** and **broths**. Rarely, a **stock vaccine** has proved beneficial. Dis-cased tonsils should be removed. Riesman (Trans. Phila. Co. Med. Soc.; Med. Rec., Apr. 16, 1921).

Where the joint pain remains severe in spite of salicylates, **Dover's powder** may be given; or, particularly at night, an injection of **morphine** may become necessary.

The complications of acute articular rheumatism should be treated according to the nature and the indications of each. Hyperpyrexia and cerebral rheumatism may necessitate the application of **tepid** and even **cold baths** combined with large doses of antipyretics; the cold baths or **cold pack** should be begun as soon as the

temperature starts to rise quickly above 105° F. (40.5° C.), otherwise considerable danger to life may be entailed. Upon the advent of endocarditis the use of the **ice-bag** or **pre-cordial blistering** should be availed of, and **digitalis** may have to be employed.

A persistently high pulse rate in acute articular rheumatism is always to be regarded as indicative of myocardial involvement, and as long as it continues absolute rest is essential. **Rest in bed** should be persisted in as long as six months to a year if the physical signs indicate that the heart has not recovered completely. During the acute stages of the disease the pain may make the patient very restless. Under these circumstances an **ice-bag** may be applied **over the heart**, and sleep should be obtained by the use of **morphine**, since the other hypnotics do not sufficiently relieve pain to permit rest. If the patient has not much pain, but is nevertheless restless, the **bromides** are of no value. When the heart remains persistently weak, and sufficient time has elapsed for inflammatory processes to quiet down, minute doses of **digitalis** and **arsenic**, continued over a long period, are often of value. Turnbull (*Austral. Med. Jour.; Therap. Gaz.*, Nov. 15, 1911).

When the fever declines, but one or more articulations remain swollen and painful, it has been recommended to employ **bandaging** for some time. Also, **baths in hot water** or, better, **hot-air baths**, will in many cases bring relief. **Massage** is likewise a valuable measure.

Iron is usually a useful remedy during convalescence, in view of the rapid anemia induced by the disease. With it may be coupled **quinine** and **strychnine**. **Arsenic** may also be of value. A generous diet should be allowed.

In rheumatic conditions associated with anemia and in sore throat of rheumatic origin, following mixture recommended: Dissolve 1 dram (4 Gm.) of **sodium salicylate** in 2 ounces (60 c.c.) of water. Add **liquor ferri perchloridi**, plus an ounce of water, giving dark-purple mixture. Then add 1 dram of **potassium bicarbonate** dissolved in 1 ounce (30 c.c.) of water, and fill up bottle to 8 ounces with water. Drinkwater (*Liverpool Medico-Chir. Jour.*, July, 1911).

No treatment has been found able to prevent surely the complications or recurrence, but most authors agree that the use of salicylates in sufficient doses continued for some time after the return of normal temperature gives the best results in both respects.

Cases showing the possibility of treatment with **colloidal sulphur**, of cutting short an oncoming chronic rheumatic state following attacks of acute rheumatism. The patient was completely relieved, resuming his occupation in three months, in spite of several interruptions in the treatment. The solution of colloidal sulphur employed contained 0.2 Gm. (3 grains) of sulphur to every 15 c.c. (½ ounce), and was given in doses of 1 teaspoonful before breakfast and supper, gradually increased to 1 tablespoonful. The solution was rendered palatable with sugar and an aromatic preparation. Sodium salicylate, having no effect on the pain or in preventing recurrence of subacute attacks, may be advantageously replaced by **quinine sulphate** in the dose of 5 grains (0.3 Gm.) twice a day. A. Robin and L. C. Maillard (*Bull. de l'Acad. de Méd.*, Nov. 25, 1913).

The writer regards all arthritic inflammation as microbic, and 90 per cent. of the cases are due to streptococci. Acute inflammatory rheumatism, chronic articular rheumatism, and arthritis deformans are but different manifestations of one cause, modified by individual susceptibility, both constitutional and local; and

duration of disease. He reports successful treatment of chronic rheumatism by means of **autogenous vaccines**. The preferable source for these is the pharynx. The benefit from vaccine ranged from total cure in the mild cases, to disappearance of all symptoms except transitory slight stiffness in the most severe. Greeley (Med. Rec., June 13, 1914).

Where a case persists over many weeks, a focus of infection in the tonsils, nasal sinuses, ears, or elsewhere in the body should be sought. **Tonsillectomy** may be required.

The writer deprecates the general tendency to refrain from operating on inflamed tonsils associated with acute joint involvement. There may be greater danger in deferring operation too long. If the tonsils are the source of infection, their continued presence increases the danger of secondary involvement of the heart. **Tonsillectomy** is indicated as soon as the acute tonsillar inflammation subsides. **Salicylates** in large doses should be used to allay joint pains before operating.

With intensive salicylic treatment the writer also gives **sterile milk** subcutaneously, thus producing hyperemia of and exudation over the involved structures. The rheumatic process is controlled in a few days. Of 70 cases treated, none developed pericarditis, and but 2 a cardiac lesion. The treatment succeeds where salicylate treatment alone seems ineffective. Endocarditis is favorably influenced by intramuscular injections of 10 c.c. (2½ drams) of sterile milk. A. Edelmann (Münch. med. Woch., Dec. 18, 1917).

Nephritis plays the chief rôle in causing senile rheumatism. If the patient is robust the writer gives **Seidlitz mixture** or **magnesium citrate** before breakfast; if frail, a **compound cathartic** pill at bedtime. **Cabinet baths** once or twice a week are very beneficial. **Salicylates** irritate the kidneys. **Heroine** usually relieves the pain in acute cases. **Superheated air** at 130°, 180°, or 200° C. is applied

to cases with a tendency to deformity. **Sodium succinate**, 10 grains (0.6 Gm.) every three hours, is often of great value. Senile rheumatism improves on **exercise**. M. W. Thewlis (Med. Rev. of Reviews, June, 1918).

MUSCULAR RHEUMATISM.

Muscular rheumatism, or myalgia, is an affection of the muscles and the related fasciæ, causing pain and stiffness, which usually disappear after some days. It sometimes assumes chronicity, being then accompanied by the formation of fibrous bands and nodules in the muscles.

SYMPTOMS.—The principal symptom is pain, which may be spontaneous or caused by movements or pressure of the diseased parts. The pain in some cases remains limited to the muscles first affected, but sometimes it suddenly disappears from these and attacks another group of muscles. Slight fever sometimes attends the affection. The symptoms vary according to the muscles affected. In rheumatism of the intercostal muscles—**pleurodynia**—(sometimes with involvement of the pectorals or the serratus magnus), breathing is painful and the disease may be confounded with pleurisy. Localized tenderness may exist over the involved muscles. When the muscles of the abdominal wall are affected, there is excessive tenderness to pressure, and the symptoms may resemble those of acute peritonitis; but the absence of fever is of great value as a diagnostic sign. Rheumatism of the muscles of the back occasionally gives rise to opisthotonos, and suspicion of spinal meningitis may arise. **Lumbago**, or involvement of the lumbar muscles, may completely incapacitate the patient, and may simulate disease of the sacroiliac joint, vertebræ, etc. Rheumatism of

the muscles of the neck causes stiffness, and, when the muscles of one side only are affected, rheumatic *torticollis* (wry-neck) is produced. The sternomastoid muscle may become prominent as a tense, tender cord, and rotates the head toward the involved side.

Pleurodynia can be distinguished from pleuritis by the absence of a friction rub, and from intercostal neuralgia by the absence of the characteristic tender or painful spots, and by the fact that the pain does not strictly follow the course of the intercostal nerves.

The acute form of muscular rheumatism passes away in a few days. The chronic form may continue for weeks and months and often provokes formation of new connective tissue, with its consequences—stiffening of the muscles and contractures. Sometimes small fibrous bands and nodules are formed in the muscles and give rise to much pain and tenderness.

Rheumatism of the muscles is in some cases complicated with myositis, which may be general or localized,—limited, for instance, to the muscle of the heart.

Muscular rheumatism is a dangerous diagnosis for a conscientious physician to make. The correct diagnosis may be either aortic aneurism, cancer of the pleura, tabes, osteomyelitis, spondylitis deformans, bone tuberculosis, syphilitic periostitis, lead poisoning, morphine habit, alcoholic neuritis, trichinosis, gonorrheal sepsis, onset of an acute infection (typhoid, influenza, variola, anterior poliomyelitis, meningitis), intestinal autointoxication, sacroiliac joint relaxation, local disease of muscle, hematoma due to trauma, hematoma following vascular change (as in typhoid, sepsis, jaundice), muscular cicatrices following fibrous myositis, atheroma of arteries in muscle (as in intermittent claudication), muscle ab-

scence, infarct, gumma, echinococcus cyst, or new growth. The diagnosis of muscular rheumatism must be made by exclusion. M. A. Rabinowitz (N. Y. Med. Jour., July 12, 1913).

ETIOLOGY AND PATHOLOGY.

—Overwork, especially when combined with exposure to cold and dampness, has always been considered as the common cause of rheumatism of the muscles. Many persons are very sensitive to draughts, and readily develop the affection, especially upon sudden cooling after physical motion sufficient to cause perspiration. The disease commonly occurs after the thirtieth year, but is also observed before that age. The disease is very liable to recur in muscles which once have been affected by it; especially in the muscles of the neck.

In all probability the muscular form of rheumatism, like the articular form, is caused by micro-organisms, but their presence in the affected muscles has as yet not been proved by direct observation.

The pathological condition produced is believed to be chiefly an inflammation of the fibrous investment of the muscle fibers, the attachments of the muscles to periosteum, and the fasciæ surrounding them. Stress is laid by some on disturbance of the sensory nerve endings in the muscles.

J. Madison Taylor states that **fibromyositis** is often a common factor in many states variously named where either pain, tenderness, or lameness is a feature. It may not be painful, merely a latent tenderness. It is often superadded to other causes of disability, complicating and obscuring them; is only to be differentiated by expert tactile exploration; the condition should be remedied to permit exact

diagnosis. The site can usually be located and evaluated by alterations in the local density, tension, mobility or restriction of motion. Nodes are often minute but characteristic.

Nearly always diagnostic light is afforded by definite tenderness and morphological alteration in paravertebral structures corresponding to the origin of the sympathetic innervation at the site of the subsidiary centers in the spinal cord.

TREATMENT.—For internal use **salicylic acid** and its compounds are much employed and will sometimes, though not in all cases, bring relief. When the **salicylates** fail to effect a cure, **tincture of colchicum**, **potassium iodide**, or **mercury** may be tried together with an **antigout diet**.

Thiosinamine at times checks progress of chronic rheumatism. Daily dosage of 0.06 to 0.1 Gm. (1 to 1½ grains) by injection or ingestion can be safely employed. Rénon (Bull. de l'Acad. de Méd., Apr. 25, 1911).

The following treatment of muscular rheumatism recommended: (1) **rest in bed**; (2) **liberal diet** of milk, eggs, light meats, farinaceous articles and cruciferous vegetables. Butter-milk and water between meals *ad libitum*; (3) **general bath** daily, with temperature progressively increased, followed by a blanket or alcohol sweat; (4) **massage**, after pain and tenderness under control at least twenty-four hours; (5) in lumbago or other localized muscular troubles where general methods inefficient: **acupuncture** or injection directly into involved muscle of 10 c.c. (2½ drams) of ice-cold normal **salt solution**; (6) where severe pain: **salicylates**, at first in large hourly doses, with **sodium bicarbonate**. Locally, 20 per cent **salicylic acid ointment** or liniment of oil of **gaultheria**, followed by **flannel jacket** or **bandages**, with **hot-water bottles** or **electric pads**. Meyer (N. Y. Med. Jour., July 5, 1913).

Externally, **tincture of iodine** and all the **rubefacients**—**ammonia**, **camphor**, **turpentine**, etc.—are to be tried; also warmth in the form of **hot water**, **poultices**, and **hot baths** (Russian or Turkish). **Hot-air baths** have been much recommended. The external use of **methyl salicylate** often alleviates the pain. **Belladonna plaster**, **chloroform liniment**, and the **galvanic current** may also be used for this purpose. **Massage** may completely cure a recent case. **Rest** of the affected muscles should be procured by all means possible. In **pleurodynia strapping** the side with adhesive plaster generally affords marked relief. In lumbago as well as in **pleurodynia** light application of the **Paquelin cautery** is frequently of marked value. Otto has recommended a single injection of 7½ to 15 grains (0.5 to 1 Gm.) of freshly obtained **sodium iodate** in 5 per cent. solution at the site of pain. Sajous **injects normal saline solution subcutaneously**—2 fluidounces (60 c.c.)—daily and gives, besides **sodium salicylate** and **sodium carbonate** (not bicarbonate) in full doses, watching the heart carefully.

Injection of 5 or 10 c.c. (80 to 160 minims) of **salt solution** into the muscle at the most painful point will frequently relieve the pain, though, of course, it has no effect upon the cause. Schmidt (Med. Klinik, vi, 131, 1910).

The chief measure, other than **rest in bed**, in the treatment of muscular rheumatism is the application of **heat** in the form of **fomentations**, **poultices**, and **hot-water bags**. **Dry cupping** over the tender region one-half hour twice or thrice daily is very beneficial. One or two electric-light bulbs placed six inches from the affected part, a piece of asbestos, tin or woolen material encircling, so as to concentrate

the heat, will produce a useful hyperemia; the skin should be protected by anointing with petrolatum. The electric-light baking apparatus is, however, more serviceable. This treatment the author has found very beneficial, together with light massage, after which a woolen cloth is placed over the hyperemic area. He has also found serviceable light massage with the use of an analgesic lubricant:—

R. Mentholis,

Camphora...āā 3i-ij (4 to 8 Gm.).

Chlorali hydrati 3ss-j (2 to 4 Gm.).

Olei gaultheriae 3ii-iv (8 to 15 Gm.).

Adipis lanae hy-drosi 3i-ij (30 to 60 Gm.).

M. et ft. unguentum.

After the patient is able to be out of bed a suitable **adhesive plaster dressing** will allow him to walk, with slight muscular fixation. J. H. Shaw (N. Y. Med. Jour., July 5, 1913).

When the disease has passed over to the chronic stage further use of **massage** and **electricity** is beneficial. **Iodine ointment** may be used with benefit. In cases attended by induration and fibrous nodules in the muscles, characterized often by continuous and very intense pain, **excision** of the hard nodules of fibrous tissue often gives immediate relief.

Chronic fibrositis is generally labelled "rheumatic," but undoubtedly not a sequel of acute rheumatism, and in no sense connected with it; the essential pathological change is, in general, an inflammatory hyperplasia of the white fibrous tissue in various parts of the body. Such affections cause pain and stiffness, the former aggravated by any sudden movement. Recurrence is common and if not suitably treated, the thickened fibrous tissue remains as indurations in various situations. The commonest causes of local fibrositis are: (1) cold, damp, and wet; (2) extremes of heat and cold; (3) local injuries, as by sud-

den and severe strain on tendons and ligaments; (4) absorption of irritating toxins from the alimentary tract; (5) tonsillitis and pharyngitis; (6) influenza; (7) febricula. The forms most commonly seen are: (1) muscular rheumatism, involving especially the muscles of the neck, those of the shoulder and upper arm (brachial fibrositis), the intercostal muscles, or the lumbar muscles (lumbago); (2) Dupuytren's contraction; (3) fibrositis of the plantar fascia; (4) pads upon finger-joints, usually confined to the dorsal aspects of the proximal interphalangeal joints, and apparently unrelated to rheumatoid arthritis, or gout. In chronic villous synovitis, though strictly not a form of fibrositis, the correct treatment is similar to that of the other conditions mentioned. It is purely local, usually occurs in the knee, and characterized by crepitus or creaking on movement, and by pain and tenderness on use.

In the treatment of an acute fibrositis, a **saline aperient** should always be given at the onset of the attack, and repeated as necessary. Salicylates are of little curative value, though **aspirin** is of decided use for the relief of pain in severe cases. **Potassium iodide** should always, if possible, be given in full doses of 10 or 12 grains (0.6 or 0.77 Gm.), combined with tonics such as **nux vomica** or the **compound glycerophosphate syrup**. If symptoms of iodism result, **iodipin** may be tried. **Fibrolysin** was employed in several cases of thickening and contraction of fibrous tissues in different forms of fibrositis and arthritis, as well as in several cases of Dupuytren's contraction, with good results in about two-thirds of the cases. It should be injected under strict antiseptic precautions into the deep subcutaneous tissues of the upper arm, each arm being injected alternately. It is necessary to give 30 to 40 injections in all, and they should be administered on alternate days. After 20 injections have been given movements and **massage** of the affected fibrous tissues should be

commenced. In the treatment of pads upon the finger-joints the only procedure found useful besides fibrolysin was the nightly inunction of a 25 per cent. **iothion ointment**. In the early stages of an acute fibrositis hot fomentations are useful. Afterward one of the best external applications is a mixture of equal parts of **chloral hydrate, camphor, and menthol**. The resulting liquid should be painted over the painful area, and then gently rubbed in with the fingers. Another useful procedure is to paint the painful area with **tincture of iodine** and then apply a hot **linseed poultice** or very hot fomentation. In the latter stages the **aconite, belladonna, and chloroform liniment** applied on lint is frequently most beneficial. In a very localized fibrositis **counterirritation**, especially by the **thermocautery**, is sometimes of great use. **Rest** of the affected parts and **diaphoresis** are two of the most important procedures in the treatment, the latter being especially beneficial at the onset of the attack. **Heat** is of great value, and if employed early will frequently abort an attack. If it is to be applied to the whole body the **electric-light cabinet** is most convenient and valuable. In lumbago and chronic villous synovitis of the knees, the most effective local treatment is **superheated air**, applied for fifteen or twenty minutes, immediately followed by **ionization (cataphoresis)** for ten to fifteen minutes. In chronic joint cases and chronic lumbago, the author orders for ionization a 2 per cent. solution of **lithium iodide**, directing that the negative ion (the iodine) should be driven into the tissues. In acute lumbago a 2 per cent. solution of **sodium salicylate** should be used at the first sitting or two in order to relieve the pain. In the later stages of a muscular fibrositis a rapidly interrupted **faradic current** is beneficial, but it should be so weak as not to cause any muscular contraction.

Massage is very useful in the later stages, but it should not be employed until it causes no pain, and should be

very gentle at first. During the painful stage of muscular rheumatism **rest** of the affected muscles is required, but later on **exercises** of the muscles are of great benefit. They should be performed on rising in the morning and followed by a cold or tepid bath and **brisk rubbing** of the skin with a rough towel. No special dieting is required; moderation should be the keynote. **Porous linen underwear** is the most suitable for rheumatic individuals. A. P. Luff (Lancet, Mar. 12, 1910).

The distinguishing pathological features of **fibromyositis**, according to J. Madison Taylor, are plastic adhesions of contiguous structures exerting compression on sensory nerve-fibers which need to be set free mechanically. While this can be achieved by various agencies such as by **counter-irritation, blisters, electricity**, etc., the most radical, prompt, and permanent relief is by expert **manipulation**, such as **deep pressures with lateral traction, torsion**, etc.; the best is by **lifting and separating the adherent structures**, thus freeing sensory fibers from compression. In some cases, fibromyositis is so persistent as to remain for many years a source of disablement, lameness, or deformity, resisting all medication, yet can be removed by manipulation in a few days. Best results from medication by **sodium benzoate** and Martin H. Fisher's **alkaline solution by colonic irrigation**.

In any of the ordinary manifestations of chronic rheumatism, as lumbago, sciatica, pleurodynia, or cephalalgia, and with any obscure myalgic or neuralgic pain in any part of the body, a careful investigation should be made of the fibromuscular tissues of the affected areas. In the more recent diffuse cases there is general tenderness of these tissues. Usually, either with or without such general tenderness, one will find areas which

are definitely, often exquisitely, tender to touch. General treatment for a feverish attack, with the ordinary pain-relieving drugs, generally suffices to cure. If the pain is at all localized a single thorough application of **massage** may result in cure in this early stage. Any discoverable cause, such as gastrointestinal irregularities, must be removed. During the more acute exacerbations **sodium salicylate** produces some relief, but recurrence is probable indefinitely. To obtain a permanent cure it is absolutely necessary to obtain locally a complete dispersal of the indurations. Counterirritation by **blistering** or **cautery** produces relief, but nothing is so efficient as the rubbing in of **oil of gaultheria**. Important also are **massage** and **systematic exercises**. **Acupuncture** is of great use in relieving pain, but does not produce complete dispersal of the infiltrations. In cases of fibrous nodules which will not yield to simpler measures, and which by pressing on nerves cause persistent pain, **excision** is not only advisable but necessary. Telling (Lancet, Jan. 21, 1911).

Senile rheumatism described as a separate morbid condition. Being one of the manifestations of aging, it can neither be prevented nor cured. Pain can, however, be relieved. The pain usually disappears soon after joint motion has ceased, but if it persists, application of **moist heat**, followed by an inunction of 2 per cent. **cocaine liniment** or **ointment**, using an animal base, will generally give relief. Sweet butter is an excellent base for this purpose. To prevent its becoming rancid 2 grains (0.12 Gm.) of **sodium benzoate** to the ounce (30 Gm.) should be added. The constitutional measures are hygienic and medicinal, the latter consisting of the intermittent use of **phosphorus** and the **iodide of arsenic**. I. L. Nascher (Amer. Med., Dec., 1911).

The writer emphasizes the value of local **heat**, especially dry, radiant heat, combined with **ionization**, in muscular rheumatism. In lumbago,

the **static current** may be substituted for ionization. **Massage** is useful, but it should not be applied to the affected part itself, but around it. A. P. Luff (Med. Rec., Aug. 16, 1913).

GONOCOCCAL (GONORRHEAL) RHEUMATISM.

Gonococcal rheumatism, or arthritis, is an acute inflammation of one or more articulations occurring during the course of gonorrhea and caused by invasion of gonococci in the joints.

SYMPTOMS.—The condition ordinarily appears in the acute stage of gonorrhea. In some cases the lesion of the joints is only revealed by arthralgia: *i.e.*, intense pain without swelling. This condition is particularly observed in the small joints of the foot. The pain is worst in the evening and is aggravated by movements. The arthralgia may also precede the evolution of gonorrheal arthritis or continue for some time after the disappearance of the swelling.

In other cases the affected joint becomes the seat of an effusion of fluid, giving rise to little or no pain. This effusion disappears very slowly, and often leaves stiffness or fibrous adhesions in the joint. This form of the disease is most frequently observed in the knee.

Ordinarily gonococcal rheumatism in its mode of invasion and evolution very much resembles the acute form of articular rheumatism. It differs from that disease, however, in attacking only one or a few articulations at the same time, and in that the affected joints remain involved for a longer period. Again, gonococcal arthritis does not migrate so suddenly from one joint to another as the acute articular affection. No joint, however, is immune, and even those which ordinarily escape dur-

ing the course of rheumatic fever, *e.g.*, the articulations of the jaws and the neck, may be attacked by the gonococcal arthritis.

The pain is of extreme intensity. It is aggravated by movements and by pressure over the swollen articulation. Many painful points are also found. Tumefaction is ordinarily very marked; it is caused both by effusion into the joint and by edema of the overlying structures. The skin over the affected joint is hot and tense.

Commonly the patient tries to alleviate the pain by keeping the affected joint semiflexed. If he is allowed to remain in this position, contraction of the extremity may result.

Gonococcal rheumatism does not affect the articulations alone. The serous bursæ and the sheaths of the tendons in the proximity of the diseased joint are always involved; sometimes they alone suffer, the inflammatory process being thus periarticular—*gonococcal tenosynovitis*. The muscles of the affected extremity are always affected and generally become atrophied.

In some cases one joint only is attacked; the pain is, then, as a rule, still more excruciating and the effusion greater than in the polyarticular form.

The acute stage of the disease is not usually of long duration. After some days or a week the pain declines and the effusion diminishes. The disease rarely disappears completely, however; one or more joints remain somewhat stiff and painful several months. The so-called *painful heel* of gonorrhea is the result of a periosteal inflammation of the os calcis, with or without exostosis. In some instances chronic gonococcal arthritis assumes the form of a persistent serous effusion.

Suppuration of the joints affected by

gonococcal rheumatism is a rare occurrence. It only happens when the infection with gonococci is complicated with invasion of pyogenic organisms. The chronic form of gonococcal rheumatism often gives rise to contracture of the joints or periostitis of the epiphyses.

DIAGNOSIS.—The diagnosis is easy when the urethral discharge is still present, but difficult when it is not. The disease may be confounded with acute articular rheumatism and with osteomyelitis. In gonococcal arthritis, but few articulations are attacked at once. The mode of development of the arthritis, the extent to which the periarticular tissues are involved, the relative absence of constitutional symptoms, the inefficacy of the salicylates, and, if possible, the demonstration of gonococci in the blood or the affected joint constitute the chief distinguishing features.

ETIOLOGY.—Gonorrheal rheumatism is caused by an infection with gonococci, and it is only observed as the consequence of a gonococcal urethritis. Many authors have found the gonococci in material taken from the affected joints or synovial sheaths, and some have even observed them in the blood. The disease attacks both sexes equally; it may occur in children as well as in adults. It develops in 2 per cent. of all gonorrhea cases in the male sex.

PROGNOSIS.—The prognosis as to life is good, but very often the disease results in stiffness of the affected joint and weakness of the limb, due to atrophy of its muscles.

TREATMENT.—Treatment by means of drugs given internally is not of great value; the salicylates have little or no influence on the course of the affection. The same

appears to be true of **potassium iodide**, except in the chronic cases. The use of **syrup of ferrous iodide** in doses of 10 to 60 minims (0.6 to 4 c.c.) three times a day has been recommended by J. C. Wilson. **Oil of gaultheria** in doses of from 5 to 20 drops every two hours in milk has also been recommended. Where acute or chronic gonorrhea coexists, every means should be taken to overcome the urethral focus of infection. In the more chronic cases the use of tonics such as **strychnine**, **arsenic**, and **codliver oil** may prove of value.

Gonococcus vaccines have given excellent results in a certain proportion of chronic cases. **Antigonococcic serum** has also been used.

At the onset of gonorrheal rheumatism, the patient should receive a purgative of **calomel** to be followed by **citrate of magnesia**, or **salts**, or a dose of **castor oil**. He should be put on a **light diet** with plenty of liquids, such as soup, milk, alkaline waters, etc., avoiding stimulating articles of diet as tea, coffee, spices, and alcohol. The bowels should be kept regular and the patient drink plenty of **water**. If necessary, a mild **diuretic** can be given. **Codeine** or **morphine** should be given if necessary for the pain. **Phenyl salicylate**, 5 grains (0.3 Gm.) and **antipyrin**, 3 grains (0.2 Gm.) may be given every three or four hours for the fever. The **oil of gaultheria** in doses of 20 drops three times a day, or **potassium iodide**, has been recommended. Every case should be treated at once with **antigonococcic serum** or **gonococcic vaccine**. The combined bacterins seem to be more useful than the single-strain cultures. The initial dose is between 10 and 20 million, running the same up every second, third, or fourth day, until about 50 million are being given every second or third day. Improvement is usually noticed within a week or ten days, but the treatment

should be continued until all the symptoms have subsided, which may take from four to six weeks. Broe-man (Med. Rev., Sept., 1913).

Local treatment is of great importance. The affected joint should be placed on a **splint** in a proper position and absolute rest of the extremity enjoined. Pain may be relieved by various anodyne measures, *e.g.*, hot and cold applications, the **ice-bag**, ointments of **ichthyol** or **belladonna**, a wet dressing of **lead-water** and **laudanum**, or, if necessary, a hypodermic injection of **morphine**. Counterirritation may be instituted by means of **turpentine** or **iodine**. Gaucher procures relief for several hours by bathing the part for half an hour in a mixture of equal parts of an aqueous emulsion of **black soap** and of **oil of turpentine**; 5 to 6 fluidrams (20 to 25 c.c.) of this mixture are used with 6 gallons (25 liters) of water. The genitals should be anointed with **petrolatum** before the bath is administered. Balzer uses the following ointment:—

℞ *Acidi salicylici*,
Olei terebinthinae,
Adipis lanae hydrosi. āā ℥iiss (5 Gm.).
Adipis benzoinati ℥iij (100 Gm.).
 Fiat unguentum.

In the intervals between local procedures a **bandage** should be applied as firmly as is practicable. Or, a **plaster-of-Paris** dressing may be used for complete immobilization, applied under anesthesia if necessary. Straightening of the limb under anesthesia is necessary if fixation in a faulty position has already taken place.

In cases in which acute pain has subsided **massage** and **passive movements** are of value to assist in res-

toration of joint mobility. Dry hot-air baths, Bier's passive hyperemia, and counterirritation with blisters or the thermocautery are also very serviceable measures in the more chronic cases. The last two procedures are especially indicated in cases characterized by hydrarthrosis. **Compression** is also of value in these cases.

Where the above fail to bring relief within a reasonable period, and especially if the effusion becomes purulent, **arthrotomy** should be performed and the joint evacuated and irrigated with an antiseptic or sterile saline fluid, according to indications. **Aspiration** followed by injection of 1 to 1½ fluidrams (4 to 6 c.c.) of a 1:4000 solution of **mercury bichloride** has been recommended by Balzer and others, but the more radical procedure in general meets with greater favor. Brès, in 20 cases, after incising the joint, removed the diseased synovial membrane and injected dilute tincture of iodine or a weak solution of zinc chloride. All his cases recovered completely.

F. LEVISON,
Copenhagen,

AND

L. T. DE M. SAJOUS,
Philadelphia.

RHEUMATOID ARTHRITIS.

See JOINTS, SURGICAL DISEASES OF.

RHIGOLENE. See PETROLEUM.

RHINITIS AND OTHER NASAL DISORDERS. See INDEX.

RHUBARB.—Rhubarb, or rheum (U. S. P.), is the root of *Rheum officinale* and of other undetermined species of *Rheum* (nat. ord., Polygonacæ): a plant indigenous to Asia (China, India, Tartary, and Thibet), but which is cultivated

in America and elsewhere. It contains extractive, sugar, starch, pectin, lignin, salts, several unimportant alkaloids, a glucoside, and acids, one of which, chrysophanic acid, is used in medicine. In commerce two sorts are recognized,—the Chinese and the European,—the former of which is considered the better. It occurs in irregular cylindrical or conical, flattened pieces, which are generally perforated, are covered with a light yellowish-brown powder, and have frequently a wrinkled surface. Beneath the powder the color of the root is reddish brown, mottled with lighter hues. The root is dense and hard and has a bitter and somewhat astringent taste and a peculiar aromatic odor. When chewed, the root is gritty (due to the presence of crystals of calcium oxalate), and imparts a yellow color to the saliva. European rhubarb is inferior to the Chinese variety; powdered rhubarb is also inferior, and, if not adulterated, at least is generally made up of inferior, damaged, worthless or worm-eaten material.

PREPARATIONS AND DOSES.—

Rheum, U. S. P. (the root). Dose, 5 to 30 grains (0.3 to 2 Gm.).

Extractum rhei, U. S. P. (extract of rhubarb). Dose, 5 to 15 grains (0.3 to 1 Gm.).

Fluidextractum rhei, U. S. P. (fluid-extract of rhubarb). Dose, ¼ to 1 dram (1 to 4 c.c.).

Mistura rhei composita, N. F. (rhubarb and soda mixture). Fluidextract of rhubarb, 15; fluidextract of ipecac, 3; bicarbonate of soda, 35; glycerin, 350; spirit of peppermint, 35; water, sufficient to make 1000 parts. Dose, 1 to 4 drams (4 to 16 c.c.).

Pilule rhei compositæ, U. S. P. (compound rhubarb pills, containing rhubarb, 2 grains; aloes, 1½ grains; myrrh, 1 grain). Dose, 1 to 3 pills.

Pulvis rhei compositus, U. S. P. (compound rhubarb powder or Gregory's powder, containing rhubarb, 25; magnesia, 65; ginger, 10 parts). Dose, ¼ to 1 dram (2 to 4 Gm.).

Syrupus rhei, U. S. P. (syrup of rhubarb, containing fluidextract of rhubarb, 10 per cent.). Dose, 2 to 6 drams (8 to 25 c.c.).

Syrupus rhei aromaticus, U. S. P. (aromatic syrup of rhubarb, containing aromatic tincture of rhubarb, 15 per cent.). Dose, 2 to 6 drams (8 to 25 c.c.).

Tinctura rhei, U. S. P. (tincture of rhubarb—rhubarb 20 per cent.). Dose, $\frac{1}{2}$ to 2 drams (2 to 8 c.c.).

Tinctura rhei aromatica, U. S. P. (aromatic tincture of rhubarb—rhubarb 20 per cent.). Dose, $\frac{1}{2}$ to 3 drams (2 to 12 c.c.).

POISONING BY RHUBARB.—Rhubarb is not generally considered poisonous, but a case has been reported in which the internal administration of rhubarb gave rise to a hemorrhagic eruption of macules, pustules, and blebs. The mucous membranes were also affected, and free hemorrhage from the urethra occurred.

THERAPEUTICS.—Rhubarb is an excellent stomachic tonic in **atonic dyspepsia** associated with deficient biliary and intestinal secretion. It is a remedy especially adapted to those of relaxed habit, but inadmissible when an hyperemia of the mucous membrane exists.

Rhubarb is a valuable remedy in simple **constipation**, where we wish to unload the bowels without affecting the general system. The root is often chewed by adults to relieve constipation. In children the syrup is a palatable preparation for this purpose; the pill or compound pill may be used by adults.

Constipation and hemorrhoids depending upon pregnancy are benefited by the administration of rhubarb.

In the **summer diarrhea of children**, with green stools, the aromatic syrup of rhubarb may be employed to empty the bowel of its fermenting contents before giving direct treatment. The **diarrhea of indigestion** in children and adults is relieved by the aromatic syrup or by the mixture of rhubarb and soda.

In children, when constipation is replaced by diarrhea, if any ordinary laxative is used, rhubarb is an available remedy on account of its secondary astringent action.

Functional disturbance of the liver with deficient biliary secretion is relieved by the administration of rhubarb, either alone or, better, combined with blue mass.

Rhubarb is an efficient remedy in duo-

denal catarrh and in catarrh of the biliary ducts with jaundice, especially in children. White, pasty, or clay-colored stools and a skin of an earthy or jaundiced hue are indications for rhubarb.

RHUS POISONING. See **DERMATITIS VENENATA**.

RIBS, DISEASES AND INJURIES OF. See **INDEX**.

RICKETS. See **BONES, DISEASES OF**.

RIGA'S DISEASE. See **MOUTH, LIPS, AND JAWS, DISEASES OF**.

RIGGS'S DISEASE; PYORRHEA ALVEOLARIS (SPONGY GUMS).—DEFINITION.—This is a pyogenic inflammation of the gums, apparently starting from the gum margins, and associated with a suppuration of the peridental membrane of the roots of the teeth, which tends to loosen the latter by detaching them from the surrounding alveolar tissue.

SYMPTOMS.—The earliest symptoms noted, as a rule, are sensitiveness, redness, and perhaps swelling of the gums, with a tendency to bleed when touched. The development of the disease being insidious, these signs are in reality those of an advanced morbid process, a fact shown in many cases by the presence of granular pustules around and under the edges of the gums, due to the formation of deep pockets between the latter and the teeth. An offensive breath and a coated tongue are usual, and periodical attacks of toothache also, though in some cases pressure over the gums will always elicit a dull pain; occasionally the latter becomes continuous. Loosening of the teeth in their sockets occurs quite frequently. A mild stomatitis is sometimes witnessed, and persistent glos-

itis with irregular exfoliation, leaving red patches, may also occur.

The disease is obviously a chronic one, but it may be attended with acute exacerbations lasting from a few days to several weeks, during which the gums become very tender and bleed spontaneously. During the ulcerative process the submaxillary or cervical glands may enlarge and become painful, suggesting tuberculosis.

Pyorrhea alveolaris is not infrequently the cause of systemic disturbances.

Many cases of septic fever of unknown origin and conditions diagnosed as malignant endocarditis, as well as many deaths attributed to acute septicemia, would have been correctly diagnosed if the oral cavity had been examined. Many deaths due to alveolar abscess, tooth extraction, and septic oral conditions have been reported.

C. H. Mayo interestingly stamps pyorrhea as the cause, not the result, of systemic disturbances. Appendicitis being caused by septic oral conditions has been confirmed by the bacteriological investigations of Lanz and Tavel.

Tooth extraction has given a comparatively high death rate. All cases presenting pus should be afforded free drainage until danger from infection has passed. A. W. Fossier (N. Y. Med. Jour., Aug. 7, 1915).

Many cases of alveolar abscess are erroneously diagnosed as pyorrhea alveolaris. This grave error was much more common before the advent of roentgenology. It has been found that the toxemia resulting from a dental granuloma is far greater than from a pyorrheal discharge. M. L. Rhein (Surg., Gynec. and Obstet., Jan., 1916).

DIAGNOSIS.—The differential diagnosis is sometimes difficult to establish from alveolar disease overlying necrosis due to poisoning by

lead, mercury, phosphorus, or other elements used industrially. Syphilitic or tuberculous lesions of the gums may also cause confusion. Scurvy, now rarely encountered, also causes gingival lesions resembling closely pyorrhea. In these various conditions the history of the case and the course of the disease are frequently of major assistance in the differentiation from true pyorrhea.

Unlike dental caries which is uncommon in "native" races, pyorrhea alveolaris is probably as common in them as in the civilized. It is very common in domesticated animals, while almost unknown in wild animals. The disease has increased enormously in civilized countries during the last few decades. Inefficient mastication, whether due to pre-existing disease of the teeth or to the food being too refined and soft, is a powerful etiological factor. Marginal gingivitis having been set up, infection with organisms rapidly follows, and a rarefying osteitis, commencing at the inner margin of the sockets, soon sets in. Lime salts from the pus become deposited on the roots of the teeth, at first around the necks just under the gum margin, and later on the deeper parts. This in itself acts as an irritant, and so a vicious circle is set up which must be broken before a cure can be effected—the tartar causes ulceration, which produces more pus, which forms more tartar. Gibbs (Edinb. Med. Jour., Oct., 1917).

ETIOLOGY.—Pyorrhea alveolaris was for a time thought to be due to the *Endameba gingivalis* (Gros, 1849), but later work seems to have definitely shown that this organism cannot be considered the causative agent. As a matter of fact, there appear to be both predisposing causes and exciting causes which play a rôle in the production of pyorrhea. Among the former are systemic diseases, localized malnutrition,

(0.03 Gm.) until the amebæ had disappeared and keeping up the effects by local applications of 2 or 3 minims (0.12 to 0.18 c.c.) of the fluidextract of *ipécac* to the gums with the tooth-brush after carefully cleansing the teeth. These agents sometimes seemed curative in mild cases, but when the morbid process was severe the organism was observed to recur.

Of 190 cases examined 187 showed endamebæ. Of the 187, 78 have been treated for pyorrhea. Of the 78 treated, none lost their endamebæ permanently. The condition of the gums and teeth was greatly improved in 3 cases, moderately improved in 9 cases, slightly improved in 22 cases, while 41 cases remained the same; the results were doubtful in 2 cases and 1 case became worse. Practically all that were found negative for endamebæ at the conclusion of the injections were found positive for endamebæ from two weeks to four months later, in spite of using a solution of *ipécac* as a mouth-wash.

Emetine is an amebicide, but alone will not cure pyorrhea alveolaris. J. S. Ruoff (U. S. Public Health Report, Reprint, 320, 1916).

Suspecting that pyorrhea is due to certain spirochetes, Kritchevsky and Séguin have used **neoarsphenamine**.

Good results in 60 cases reported from **mercury succinimide** injections. In the pyorrheal secretions numbers of large spirochetes were observed which generally disappeared almost completely as a result of the injections. Among 244 cases the spirochetes were found in large number in three-fourths of all instances. In healthy mouths, they were usually absent or few. Six to 10 injections of 0.1 to 0.6 Gm. of **neoarsphenamine** among 42 patients all showing numerous spirochetes caused disappearance of the latter in 29 cases, in the absence of all local treatment. Clinical improvement was marked. The treatment recommended for pyorrhea is as

follows: Intravenous injection of 0.1 to 0.3 Gm. of **neoarsphenamine**. If contraindications or special technical difficulties exist, intramuscular injections of **mercury succinimide**. Where the tooth is entirely loosened and the alveolar process destroyed, the tooth had best be removed. If the process is but partly involved the roots should be scraped and even carefully polished. Fluorine salts assist in breaking up the tartar. **Neoarsphenamine** should also be introduced in the pyorrheal pockets in solution or powder form. Recurrence is obviated only by persistent, careful cleansing of the teeth. B. Kritchevsky and P. Séguin (Presse méd., May 13, 1918).

Some observers have reported good results from the use of a **stock bacterin** or **autogenous vaccine**.

In the cases studied by the writers, streptococci predominated, but were associated in some instances, either with *Staphylococcus aureus*, *S. albus*, or with *S. citreus*. In 2 cases there was found an association of the streptococcus and of the *Bacillus pneumoniae*, once with the *Micrococcus catarrhalis*, and twice with a pneumococcus.

A **sensitized vaccine** against the streptococcus, staphylococcus, pneumococcus, and bacillus of Friedländer was thereupon prepared. For *M. catarrhalis* a Wright vaccine was made. Vaccine injections were then made. After 2 injections, when the antibodies began to take hold, a mechanical and dental treatment—Younger's—was begun. After from 4 to 5 injections, it was found impossible, either by microscopic examination or by cultures, to discern the presence of the bacteria. The authors have kept in touch with a number of cases for six months after treatment. These cases have shown no recurrence. Bertrand and Valadier (N. Y. Med. Jour., Jan. 10, 1914).

A **stock vaccine** may be used, either sensitized or unsensitized, or an **autogenous vaccine** prepared from the pus pockets may be employed. If the autogenous is preferred, care

should be taken to select an experienced bacteriologist for its preparation. If an unsensitized bacterin is employed, the initial dose advised is 150 million of the mixed bacteria; 250 to 750 million may be given as the initial dose if the sensitized cultures are employed. Subsequent doses are injected at intervals of seven to ten days, gradually increasing or decreasing according to indications. If the reactions are too severe, the doses should be reduced or temporarily discontinued. Every dose should be carefully gauged by the effect obtained from the preceding dose. If no improvement follows the initial dose, subsequent injections should be increased until amounts large enough to produce a mild clinical reaction (demonstrated by symptoms of malaise and possibly aggravation of the local symptoms) are reached. If a marked clinical reaction occurs after a dose, characterized by rising temperature, the next dose should be smaller. F. E. Stewart (N. Y. Med. Jour., Aug. 7, 1915).

Injections of **succinimide of mercury** (1 grain—0.065 Gm.) weekly are announced as curative by Wright and White (U. S. Navy), from one to six doses having been sufficient in their cases besides the local measures. Copeland (Dental Cosmos, Feb., 1916) confirms these observations. He used a B. W. & Co. glass syringe holding 40 minims (2.5 c.c.) and a No. 26 intramuscular needle, the solution being $\frac{1}{8}$ grain (0.013 Gm.) of mercuric succinimide to 4 minims (0.25 c.c.) of hot, sterile distilled water. The injections are made into the buttock after sterilization of the skin.

The writer advocates surgical measures, removing the diseased tissues under **novocaine anesthesia**, then packing with **iodoform gauze** to promote drainage and granulation. The patient is shown how to flush his teeth

with warm saline solution after eating for the post-operative week. This operation does not cure pyorrhea; it is the only method which prevents secondary infection. Nodine (Dental Cosmos, lxiii, 345, 1921).

The writer resorts to gingivectomy, cutting away under local anesthesia all loose, infected and diseased tissues to eradicate periodontal infection. He claims to have obtained a cure in 90 per cent. of his cases. Ziesel (Dental Cosmos, lxiii, 352, 1921).

Time will probably show that such active surgical procedures are unnecessary to cure pyorrhea.

Prophylaxis is an important feature: scrupulous cleanliness of the mouth and regular visits to the dentist to check any incipient disorder of the teeth or gums.

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RINGWORM. See TRICHOPHYTOSIS.

ROCHELLE SALTS. See POTASSIUM AND SODIUM TARTRATE.

ROCKY MOUNTAIN SPOTTED FEVER (TICK FEVER).—This eruptive disease has been known in the valley of the Bitter Root River in Western Montana and in Idaho since 1873, although the first specific reference to it in literature was made in 1896 by the Surgeon General of the Army in his annual report. The disease has since been reported from nearly all the States in the Rocky Mountain group, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington and Wyoming. Cases have also been reported from the District of Alaska. The disease is especially interesting on account of its geographical limitation, seasonal prevalence, intimate association with

wood ticks, and variation in severity in different localities. It is apparently confined to the American Continent, being found only between 40° and 47° north, and at an average elevation of between 3000 and 4000 feet above sea level. It prevails exclusively in the spring and early summer; in the Bitter Root cases the earliest was March 17 and the latest July 17. Those whose duties take them into the brush and expose them to the bite of ticks are subject to the disease, especially stockmen, sheep herders, miners, prospectors, lumbermen and ~~gamekeepers~~. The greatest mortality is in persons between 15 and 50 years of age, presumably because they are most actively engaged in outdoor work, and, for the same reason, males most often fall victims to this disease. It is not contagious; 2 cases of the disease have never been observed in the same family the same season.

SYMPTOMS.—Incubation.—There is a stage of incubation lasting from three to ten days, usually about seven. For a few days the patient complains of chilly sensations, malaise, and nausea, then has a distinct chill and takes to his bed. Soon there are pains in the back and head, and a feeling of soreness in the muscles and bones, with a sensation as if the limbs were in a vice. The bowels are constipated and the tongue is covered with a heavy white coat, but red at the tip and edges. The conjunctivæ are congested, and later become yellowish in color. The urine is usually scanty and contains albumin and casts. Epistaxis, at times alarming, is always present, and slight bronchitis appears after a few days.

Fever.—Before the distinct chill there is a slight rise of temperature

in the afternoon, but little or no fever in the morning. After the chill there is an abrupt rise, with a gradual increase of the fever in the evening, and a slight morning remission, the maximum being usually reached between the eighth and twelfth days. In a favorable case it then gradually falls, reaching normal about the fourteenth to the eighteenth day, usually going to subnormal for a few days. In fatal cases the fever remains high (104° to 106° F.—40° to 41.1° C.), and the morning remissions are either absent or very slight. Yet the temperature ~~remains rising to 105° or 106° F.~~ (40.6° to 41.1° C.) by the seventh or eighth day, ending in favorable cases by lysis on the ninth or tenth day.

Circulation.—The pulse is accelerated out of all proportion to the temperature, a pulse of 120 being common with a temperature of only 102° F. (38.8° C.); the pulse usually varies from 110 to 140; it is weak and thready; a full, strong pulse is exceptional; during the first week it may be dicrotic. There is a progressive diminution in the number of red blood-cells, but when the temperature reaches normal an increase begins.

The white blood-corpuscles are increased in number varying from 8,000 to 12,000; an average differential count would give: polymorphonuclear leucocytes, 77.7 per cent.; large mononuclears, 11.4 per cent.; small lymphocytes, 10 per cent.; eosinophiles, 0.9 per cent.; the most marked feature being an increase in the large mononuclears. The hemoglobin is steadily but slowly decreased—it may go as low as 50 per cent. The blood will not agglutinize *Bacillus typhosus*; fresh and stained blood contains three forms of the pathogenic parasite.

A sudden rise in the leucocyte count is an unfavorable sign.

Eruption.—On the third day the eruption usually appears, first on the wrists and ankles, then on the arms, legs, forehead, back, chest, and, last and least, on the abdomen. Although the other portions of the body may be closely covered by the eruption, it is always scanty on the abdomen.

The spots are at first bright-red, always macular, and in size from a pinpoint to a split pea, at first disappear on pressure and return quickly; in severe cases they rapidly become darker, even purplish in color. From the sixth to the tenth days of the disease, the spots do not disappear on pressure and are decidedly petechial in character. In favorable cases, about the fourteenth day they lose their petechial character and disappear slowly on pressure. The eruption may assume the appearance of a turkey-egg, the skin being flecked with small, brownish spots. The eruption fades as the fever declines, but an access of fever, a warm bath, or a free perspiration will bring it out distinctly. Desquamation begins when convalescence is well advanced and is general. In very severe cases there may be gangrene of the fingers, toes, and more frequently of the skin of the scrotum and penis. Jaundice is always present, first in the conjunctivæ and later involving the entire cutaneous surface.

The Gastrointestinal Tract.—The tongue is covered at first with a heavy, whitish coat, except on the edges and tip, which are red; later the coating is dark brown and sordes covers the teeth. The appetite is often good throughout the first week,

although there may be slight nausea. In fatal cases the nausea increases during the second week and persists. Constipation is always present and continuous. Gurgling is seldom found in the right iliac fossa and tympanites is never excessive. Moderate increase in the size of the liver is present, and the spleen is enlarged early and may extend one or two inches below the ribs. Black vomit is common.

The Urinary Tract.—The urinary output is one-half the normal. Albumin in small amount is present in all cases, associated with granular, hyaline, and epithelial casts. Nephritis may appear early in the history of the case.

The Respiratory Tract.—The respirations are always accelerated, being usually from 26 to 40 per minute, although they may reach 50 to 60; they are regular but often shallow. Slight bronchitis always appears in the second week. In fatal cases lobar pneumonia is a frequent complication. Epistaxis is generally observed from the beginning of the second week.

Nervous System.—Headache and pains in the back are usually severe during the first week. A feeling of soreness in the muscles and bones, often very severe, even in mild cases, is present and persists until recovery. The mind is usually clear, in severe cases, until a few hours before death.

DIAGNOSIS.—Diagnosis is usually easy in cases occurring in infected localities, which present a history of tick-bites and the typical symptoms of this disease; a blood examination will clear up any doubtful case. There are, however, five diseases to which it bears more or less close resemblance from which this disease must

be differentiated: dengue, cerebrospinal meningitis, peliosis rheumatica, typhoid and typhus fevers.

Dengue is a disease of tropical and subtropical countries, while spotted fever is found at elevations of from 3000 to 4000 feet above sea-level. The swollen joints, polymorphic eruption (never petechial) over the joints, apyretic period, and short duration of dengue would distinguish it.

Cerebrospinal meningitis is marked by the characteristic stiffness of the neck muscles, photophobia, extreme sensitiveness to sudden noises, headache, rigidity of the muscles of the back and neck, and a rash which is not only irregular in location, but also in appearance.

Peliosis rheumatica is a comparatively rare disease in which there is a characteristic sore throat associated with multiple arthritis, purpura, and urticaria.

Typhoid fever clinically closely resembles spotted fever except in the rose-colored spots (papular) which appear first on the abdomen, the diarrhea, the Widal reaction, the presence of typhoid bacilli in blood-cultures, and the absence of the parasites formed in the red blood-cells of spotted fever.

Typhus fever so closely resembles spotted fever that cases of typhus fever occurring in a spotted-fever district, without a blood examination and close clinical observation, might easily be confounded with it. In typhus fever, however, we have a larger incubation, absence of tick-bites, the eruption which appears first on the abdomen and chest, and an intensely contagious character. Typhus is, moreover, especially prevalent during the winter months, and not during the

late spring and early summer, and is accompanied by marked nervous symptoms.

ETIOLOGY.—Spotted fever is caused by a protozoan parasite which is transmitted to man through the bite of the wood tick (*Dermacentor andersoni*). To Wilson and Chowning belongs the credit of discovering this parasite, three forms of which have been identified by John F. Anderson. The most common is a single ovoid body, refractile, situated within the red blood-cell, usually near its edge, and closely resembling the earliest intracorpuseular parasites of estivo-autumnal malaria. When the blood upon the freshly prepared slide is warmed the parasite quite rapidly projects pseudopodia and may change its position slightly. A second form, somewhat rarer, is larger, and larger at one end and showing there a dark, granular spot; this form is also ameboid. The third form, arranged in pairs, is pyriform in shape, with the smaller end approaching, and in some cases being united by a fine thread.

The parasite is developed in the female tick and the young ticks, after being hatched, transmit the infection. The female gets her infection by biting one convalescent from spotted fever.

Three types of the spotted fever parasite can be recognized: (1) An extranuclear bacillus-like form without chromatoid granules, relatively large and only present in ticks during the initial multiplication of the parasites; (2) a relatively small rod-shaped form with chromatoid granules, probably the same form seen within nuclei in sections of ticks, and rarely in smooth muscle cells in the blood-vessel of mammals; and (3) a relatively large lanceolate paired form present in ticks and in the blood and

lesions in mammals. The name *Demacentroxenus rickettsi* is proposed. S. B. Wolbach (Jour. Med. Research, Nov., 1919).

PROGNOSIS.—The mortality varies between 70 and 90 per cent. Death usually occurs between the sixth and the twelfth day. There is no relation between abundance of the eruption and severity of the disease.

TREATMENT.—Quinine bismutate in 15-grain (1 Gm.) doses every six hours, preferably hypodermically, has yielded excellent results in the hands of Wilson and Anderson. Quinine sulphate, 15 grains (1 Gm.), may be given by mouth every four hours, and should be begun as soon as the diagnosis is made, and persisted with in decreasing doses as convalescence begins. The heart should be supported with strychnine, whisky (egg-nog), or other cardiac stimulants.

The severe pain in the head and back, during the first week, may be relieved by the use of **Dover's powder** or **morphine sulphate**. It is well to flush the kidneys through the use of copious draughts of **water**. **Warm sponge baths or packs** are useful in controlling the fever. The room should be **darkened and free from noise**. In the way of diet milk, butter-milk, broths, soft-boiled eggs, and moistened toast may be given.

In the way of prophylaxis, Anderson advises that as soon as a person is bitten by a tick the insect should be removed and 95 per cent. carbolic acid applied to the spot. If there is difficulty in removing the tick, Anderson suggests the application of ammonia, turpentine, kerosene, or carbolyzed petroleum to it.

The treatment is rather unsatisfactory, being mainly supportive and

symptomatic; the only drug of much service is **sodium citrate** given intravenously to the limit of tolerance from the start. Sixty c.c. of a 5 per cent. fresh sterile solution may be given intravenously twice daily. H. C. Michie and H. H. Parsons (Med. Rec., Feb. 12, 1916).

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RUBELLA. Rötheln, German measles.

DEFINITION.—Rubella is an acute, infectious, contagious disease of mild character, presenting somewhat variable symptoms and running a favorable course. Its identity as a disease, *sui generis*, was long doubted. There is now no question, however, that it is a distinct entity among diseases, though it strongly resembles in its different manifestations measles and scarlet fever. No better statement of present beliefs regarding its true character has been made than that of Griffith, which is as follows: "(1) rubella is a contagious, eruptive fever, and not a simple affection of the skin; (2) it prevails independently either of measles or of scarlet fever; (3) its incubation, eruption, invasion, and symptoms differ materially from both of these diseases; (4) it attacks indiscriminately and with equal severity those who have had measles and scarlet fever and those who have not, nor does it protect in any degree against either of them; (5) it never produces anything but rubella in those exposed to its contagion; (6) it occurs but once in the individual."

PERIOD OF INCUBATION.—This period is, according to Holt, 8 to 16 days, the limits being 5 to 22 days; Rotch, 21 days; Edwards, 7 to 14 days; Plant, 1 to 3 weeks; Smith, about 2 weeks. These figures clearly

show that the period of incubation is of considerable length and extremely variable. The indefiniteness arises not so much from lack of observation as from variability in the disease. To say that the period of incubation is about two weeks is probably as correct and definite a statement as can be made.

SYMPTOMS.—The symptoms of rubella are extremely variable, so much so in fact that we must agree with Rotch that it is impossible to describe a typical case in such a way that the disease can be certainly diagnosed in a sporadic case. Many cases, however, run a fairly consistent and characteristic course. The invasion is seldom severe. In some cases there is a prodromal stage lasting a few hours; in others the rash is the first symptom to be observed. The fever is rarely high and often does not rise above 100° F. (37.8° C.), but commonly, when at its height, on the first day of the eruption, it reaches 101° or 102° F. (38.3° or 38.9° C.). It occasionally rises to 104° F. (40° C.) or more. The drowsiness, stupor, and other evidences of serious illness so frequently seen at the height of measles are rarely, if ever, seen in rubella. A child with a bright and very extensive eruption will frequently show no sign of general illness.

In my own experience sore throat has been the rule. The tonsils and pharynx are red and swelled and there is pain on swallowing. This is occasionally so marked as to be suggestive of scarlet fever; the vomiting so common at the outset of that disease, however, is rarely present. A secondary sore throat which comes on as the disease is subsiding was first

noted by Eustace Smith as very characteristic of rubella. It certainly occurs in some cases. Koplik's spots do not appear. The symptoms of the primary angina subside on the second or third day and rapidly disappear. There are no catarrhal symptoms in most cases, but occasionally slight suffusion of the eyes and a mild catarrh will render the diagnosis from measles more difficult. Albuminuria is rarely if ever present, and the diazo-reaction is extremely rare. Moderate leucocytosis occurs during the incubation period, but disappears as the eruption fades.

Hematological diagnosis of *rötheln*. Three cases under treatment appeared clinically as measles, but the first soon proved itself *rötheln*. Two weeks later two similar cases were admitted. The writer then compared the blood-counts of the cases with examples of true measles. He found that in *rötheln* at the high point of the disease there was none of the disappearance of eosinophiles which characterizes measles; nor was there the leucopenia regarded as normal in the latter disease. Schwaer (Münch med. Woch., May 27, 1913).

Enlargement of the postcervical and suboccipital glands is a very constant and very characteristic symptom of rubella. Numerous small glands may almost invariably be felt behind the sternomastoid well down toward the shoulder; they rarely become very large and never suppurate. They may be felt most distinctly when the rash is at its height, and disappear rapidly. While they aid materially in diagnosis, and may perhaps be called diagnostic, they are certainly not pathognomonic, for they may at times be met in measles and in rare cases be found in scrofulous children without febrile symptoms.

Most salient features by which one may distinguish rubella from measles and scarlet fever are as follows, as given by N. S. Manning:—

	RUBELLA.	MEASLES.	SCARLET FEVER.
<i>Invasion</i>	<i>Nil.</i>	Three to five days, with pyrexia and conjunctival and bronchial catarrh.	Twelve to twenty-four hours, pyrexia, headache, and vomiting.
<i>Catarrh</i>	Slight or absent.	Marked conjunctivitis, coryza, cough, etc.	Absent.
<i>Eruption</i>	Appears on face and chest as bright, pink-red macule, first under the cuticle, which become raised, with tendency to spread and form irregular patches or become diffuse.	Appears on face as darkish-red, slightly raised papules; extends to trunk and limbs; papules become confluent, but distribution is more uniform.	Appears on chest as diffuse general redness of skin.
<i>Throat-lesions</i>	Slight swelling and injection of fauces.	Fauces injected.	All the faucial structures acutely inflamed, swelled and red, or ulcerated.
<i>Tongue</i>	Furred.	Furred.	Thickly furred, which begins to strip off in twenty-four or forty-eight hours, leaving raw surface, with enlarged papillae.
<i>Superficial lymphatic glands</i>	Always enlarged in axillae, groins, and behind sternomastoid muscle in neck.	May be enlarged at angles of jaw and behind sternomastoid muscle.	May be enlarged at angles of jaw and behind sternomastoid muscle.
<i>Desquamation</i>	Absent or very slight.	Branny.	Characteristic peeling off of large pieces of epithelium.

Forchheimer describes an exanthem which is seen in the mouth as the exanthem appears on the body. It usually lasts about twenty-four hours. "It consists of a macular, distinctly rose-red eruption, upon the velum of the palate and the uvula, extending to but not on the hard palate. The spots are arranged irregularly, not crescentically, of the size of large pinheads, very little elevated above the level of the mucous membrane, and do not seem to produce any reaction upon it."

The eruption appears first upon the

face or forehead and extends rapidly over the neck, trunk, and limbs. The whole body is usually covered within twenty-four hours. Occasionally the child will wake in the morning with a rash covering the greater portion of the body. In many cases the rash is limited to small areas, the greater portion of the body escaping entirely. It is more constant upon the face than any other region. In some cases the rash continues not more than twenty-four hours, but, as a rule, it is present from two to four days. Itching is common at the outset.

A slight, scaly desquamation may follow the disappearance of the rash, but in many cases no desquamation can be detected. This is particularly true when inunction of the body has been practised.

The eruption consists of papules or maculopapules of a red or rose-red color. They vary greatly in size, varying from a pin's-head point to a large blotch. This multiform character is one of the peculiarities of the eruption of rubella. Most of the spots are smaller than those of measles and larger than those of scarlet fever. They vary in size on different portions of the body, and even in the same region the rash will be found, as a rule, to be made up of small dots interspersed with larger and irregular-shaped spots or blotches. It lacks the uniformity of the rash seen in scarlet fever or measles. The rash more commonly resembles that of measles and it is frequently impossible to make a diagnosis from it alone. Edwards has recently alleged that he has not seen the rash resemble that of scarlet fever. That is not my experience. I have frequently seen a rash consisting of small points grouped closely upon a reddened skin that looked extremely like scarlet fever. Search over the body, in such cases, however, will usually reveal small areas of eruption composed of maculopapules, appearing as large spots. These are commonly found upon the arms, wrists, or hands. I quite agree with those who describe a scarlatinal and rubeolar type of eruption. I have seen these two types well marked in two children of the same family exposed at the same time, and ill in the same room. The rash of one, consisting of large maculo-

papules very strongly resembled measles; that of the other, consisting of much finer points on a reddened skin, as strongly resembled scarlet fever.

A disease was described by Clement Dukes, of England, in 1900, to which he gave the name of "*Fourth Disease*." The condition which is described is virtually that which I have here described as the scarlatinal form of German measles. The differential diagnosis given by Dukes between German measles and fourth disease describes a condition identical except as to the rash. He admits that in the same patient the eruption sometimes resembles measles and may change later to a scarlatinal type.

The subject has received extended study since Dukes promulgated the theory of a fourth disease. After careful observation of 1335 cases seen in the London Fever Hospital, Beards and Goldie did not see any they felt they could record as fourth disease. Watson Williams made a very careful study of 32 cases of rubella and questions the existence of a fourth disease. Pleasants, of Baltimore, also concludes that the existence of a new exanthematic disease has not been established. After an extended review of the whole subject Ker concludes that the fourth disease is either mild scarlet fever or atypical rubella. From study of the literature and from considerable experience it seems to me that we have not sufficient evidence to warrant us in describing a fourth disease.

ETIOLOGY.—Analogy leads to the belief that rubella is caused by a specific micro-organism, but the germ has not yet been discovered. It is contagious, though not as strongly so

as scarlet fever and measles. Its contagious power at times seems to be very slight. It is most contagious when the eruption is at its height. It is rarely, if ever, seen under six months, but after that age no period of life is exempt. It is most common between 5 and 10 years. The recurrence of true rubella is rare. The disease usually occurs in epidemics, which are most common in the spring.

COMPLICATIONS AND SEQUELÆ.

—No other infectious disease is so free from complications. This is, in fact, one of the most marked peculiarities of rubella. Even varicella sometimes shows a serious complication: that of gangrene. No such serious symptom is likely to arise in rubella. The pneumonia, otitis, erysipelas, and multiple abscesses, which in rare instances have been reported as accompanying rubella, are perhaps not in every case a complication, but rather a coincidence.

The writer reports the following unusual case: The patient, a male, developed, after a few days of sore throat, stiff neck, malaise, and moderate fever, a rash having the distribution and appearance of German measles and accompanied by an enlargement of superficial glands, notably those of the neck. Before the exanthem had faded the patient began to complain of stiffness and tenderness in the knees and ankles, and soon all the interphalangeal joints of the fingers presented the spindle-like swelling commonly seen in rheumatoid arthritis. There was no exacerbation of temperature and neither cardiac nor other complication. A fortnight from the appearance of the rash all the symptoms were subsiding, and in the six months there was only an occasional transient stiffness in the fingers. D. A. Alexander (Lancet, ii, p. 921, 1907).

In an epidemic in an institution for children, out of 80 cases 2 children developed chickenpox before recovering from rubella, 1 developed rubella before recovering from chickenpox, and 1 child had a severe ulcerative stomatitis. May Michael (Arch. of Pediat., Aug., 1908).

PROGNOSIS.—Death from rubella is extremely infrequent. In rare cases in which it occurs it is usually the result of some pulmonary disease, occurring either as a complication or as a coincidence.

TREATMENT.—Rubella requires very little, if any, treatment. Mild treatment appropriate to any febrile condition is permissible, but if the patient is kept in bed while the fever and rash continue, and is anointed daily with oil, further treatment will rarely be required. Symptoms must be treated as they arise. In most cases the disease as such is of but little importance, its chief interest lying in its diagnosis, owing to its resemblance to two more serious diseases.

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RUBEOLA. See MEASLES.

RUE.—Rue (*Ruta*) is the leaves of *Ruta graveolens* (fam. Rutacæ), a perennial herb or undershrub of Southern Europe, but cultivated elsewhere as a domestic medicinal herb. The important constituent (0.06 per cent.) of rue is a volatile oil, colorless or slightly yellow and of low specific gravity, and extremely unpleasant and odorous. It was official in the U. S. P. from 1870 to 1890. Rue also contains a glucoside (rutin-rutic or rutinic acid) which is yellow and crystalline and apparently identical with the barosmin of buchu, considerable sugar, and possibly a volatile alkaloid.

PREPARATIONS AND DOSES.—*Oleum ruta* (oil of rue). Dose, 3 to 6 minims (0.20 to 0.40 c.c.), in capsule.

Ruta (rue). Dose, 15 to 30 grains (1 to

2 Gm.), usually in infusion. Neither preparation is now official.

PHYSIOLOGICAL ACTION.—Rue is a local irritant and vesicant. Internally it is a stimulant, carminative and emmenagogue. In large doses it is an irritant poison, producing severe gastroenteritis, vomiting, abdominal pain and meteorism, bloody stools, suppression of urine, or stranguary, and epileptiform convulsions. Dimness of vision with contracted pupils are observed. Abortion may result from toxic doses. It has some special action upon the genitourinary tract, and is eliminated in the breath, the urine, and in the perspiration. It is rarely fatal.

THERAPEUTIC USES.—In medicinal doses it is given as a uterine stimulant in

atonic amenorrhea, menorrhagia, and metrorrhagia. Its employment as an abortifacient entails great danger to the mother. Hysteria, especially when associated with amenorrhea, is benefited by the drug. It has also been found useful in flatulence and infantile convulsions. In defective activity of the sexual organs, it acts as an aphrodisiac and emmenagogue. The bruised leaves of rue laid upon the forehead has been used by Phillips to check epistaxis. Added to liniments rue has found favor as an application to the chest in chronic bronchitis. A decoction of the fresh leaves may be used as an injection against seatworms (oxyuria) and has often been given internally to expel roundworms (ascarides). W.

S

SACCHARIN.—Saccharin (benzophenidinum, U. S. P.; glusidum, Br.; neosaccharin; gluside; benzoyl sulphonic-imide), or the anhydride of orthosulphamide—benzoic acid ($C_7H_5NO_3S$), is a coal-tar derivative obtained commercially from toluene discovered by C. Fahlberg in 1879. Saccharin occurs as a white, crystalline powder, nearly odorless, having an intensely sweet taste even in dilute solutions. It is soluble in 250 parts of water and in 25 parts of alcohol, and but slightly soluble in ether and chloroform. It readily dissolves in 24 parts of boiling water. Saccharin dissolves also in glycerin. Its solubility in water is promoted by the addition of sodium bicarbonate in the proportion of 2 parts to 3 of saccharin. Saccharin forms soluble salts with the hydrates of the alkaline metals. It melts at $220^\circ C.$ ($428^\circ F.$), and when fused with potassium or sodium hydroxide it forms salicylic acid. It is 300 times sweeter than cane-sugar.

Sodium saccharin, also known as soluble saccharin, soluble gluside, and crystallose, is prepared by neutralizing an aqueous solution of saccharin with sodium carbonate or bicarbonate and slowly crystallizing the solution. It occurs in colorless crystals, very soluble in water, intensely sweet to the taste, and not dis-

colored by concentrated sulphuric acid. It is a favorite substitute for saccharin because of its greater solubility.

Saccharin when present in food products or mixtures may be separated by extracting the saccharin from an acidulated solution of the substance with ether, separating the ether and then evaporating the ethereal solution thus obtained. The average dose of saccharin is 3 grains (0.2 Gm.).

PHYSIOLOGICAL EFFECTS.—Saccharin apparently is not decomposed in the body, as it is excreted by the kidneys unchanged; the urine, however, does not so readily undergo fermentation and the chlorides are increased. Mathews and McGuigan, in studying the effects of saccharin on oxidation and digestion, report that it has a marked retarding action on oxidation in the blood and muscles, and also on the action of the digestive juices, especially those of the salivary glands and pancreas. Its prolonged use is likely to cause digestive disorders. When injected into the circulation of an animal, it produces depression and stupor, followed by labored respiration, similar to asphyxia. The writers attribute these effects to its inhibitory action on the enzymes of the blood and tissues, which also explains the headaches and other symptoms its use often gives rise to. It is believed to be a

general protoplasmic poison in that it inhibits nearly all the fermentative processes of the body, and interferes with and diminishes general bodily metabolism. Saccharin has antiseptic properties which, however, are impaired in the presence of an acid medium.

POISONING BY SACCHARIN.—

Large doses of saccharin are capable of producing marked toxic symptoms, as in a case reported by Luth, where a woman having swallowed about 30 grains (2 Gm.) of saccharin was found in a state resembling that of alcoholic intoxication. She was unconscious and foamed at the mouth. Her face was flushed and she suffered from convulsive attacks, with choking. The respirations were rapid and the pulse weak, very rapid, intermittent, and irregular. Poisoning by saccharin is rather rare.

TREATMENT OF POISONING.—In the foregoing, under **artificial respiration** and **massage of the heart**, the pulse within half an hour became stronger and regular, and the respiration became normal. After forty-five minutes the patient awoke and felt quite well.

THERAPEUTIC USES.—Saccharin is chiefly used as a substitute for sugar in the diet of **obese** and **diabetic patients**. Tablets containing $\frac{1}{2}$ grain (0.03 Gm.) of saccharin combined with a small quantity of sodium bicarbonate are conveniently carried by these patients to be used in tea, coffee, etc. It may also be prescribed in the form of a syrup containing 10 parts of saccharin and 12 parts of sodium bicarbonate in 1000 parts of distilled water, made with gentle heat at 104° F. (40° C.). Saccharin in small doses has been used in **acid dyspepsia** and in **chronic cystitis** with ammoniacal urine. Two parts of saccharin in solution with 3 parts of sodium bicarbonate forms a good **tooth-wash**. **Aphthæ** yields to saccharin; 15 grains (1 Gm.) of saccharin are dissolved in 1½ ounces (50 c.c.) of alcohol, of which a teaspoonful is added to a half-cup of water, and used to wash the mouth thoroughly four or five times a day. It may be used to cover the taste of quinine, 1 part of saccharin to 2 of quinine being used. As saccharin retards the action of all the digestive ferments, it is contra-indicated in cases in which digestion is already impaired. W.

SALICYLIC ACID, THE SALICYLATES, AND SALICIN.—

Salicylic acid, chemically ortho-oxybenzoic acid [$C_6H_4(OH)COOH$] is an organic acid existing naturally in the oils of wintergreen (*Gaultheria procumbens*) and of sweet birch (*Betula lenta*) in combination as methyl salicylate. It was first artificially made in 1874 by Kolbe, who produced it from phenol, caustic soda, and carbon dioxide with the aid of moderate heat and subsequent treatment with hydrochloric acid. The solubility of salicylic acid in water, normally relatively slight, is increased by the addition of the phosphates, citrates, or acetates of the alkalies, and by borax (sodium biborate). Pure salicylic acid should be free from color and from the odor of phenol; when heated on platinum foil, it should leave no ash.

Various salts of salicylic acid are official. There are also in common use a number of other substances containing the salicyl radicle, including such drugs as acetyl-salicylic acid and salicin. The last named, a glucoside obtained from the bark of several species of *Salix* and *Populus*, supplied the original name for the entire group of drugs, the word salicyl being derived from *Salix*.

PREPARATIONS AND DOSE.—the following salicyl preparations are official:—

Acidum salicylicum, U. S. P. (salicylic acid), occurring in fine prismatic needles or a bulky, white powder, with a slight odor of wintergreen and a taste at first sweetish, then acid. It is soluble in 308 parts of water at 77° F., and in 14 parts of boiling water, and in 2 parts of alcohol, in 60 parts of glycerin, and in 2 parts of olive oil

(with the aid of heat). Dose, 5 to 20 grains (0.3 to 1.3 Gm.); average, $7\frac{1}{2}$ grains (0.5 Gm.).

Ammonii salicylas, U. S. P. (ammonium salicylate) $[\text{C}_6\text{H}_4(\text{OH})\text{COO}\cdot\text{NH}_4]$, occurring in prisms or plates or as a white, crystalline powder, odorless, with a saline, bitter taste and sweetish after-taste. It is freely soluble in water and alcohol. Dose, 3 to 15 grains (0.2 to 1 Gm.); average 4 grains (0.25 Gm.).

Sodii salicylas, U. S. P. (sodium salicylate) $[\text{C}_6\text{H}_4(\text{OH})\text{COONa}]$, a white microcrystalline or amorphous powder, occasionally with a faint pink coloration, and having a sweetish, saline taste. It is soluble in 0.8 part of water and in 5.5 parts of alcohol, and also dissolves in glycerin. Dose, 5 to 20 grains (0.3 to 1.3 Gm.).

Strontii salicylas, U. S. P. (strontium salicylate) $[(\text{C}_6\text{H}_4(\text{OH})\text{COO})_2\cdot\text{Sr}+2\text{H}_2\text{O}]$, a white, crystalline powder with a sweetish, saline taste, soluble in 18 parts of water and in 66 parts of alcohol. Dose, 5 to 20 grains (0.3 to 1.3 Gm.).

Phenylis salicylas, U. S. P. (phenyl salicylate; salol) $[\text{C}_6\text{H}_4(\text{OH})\text{COOC}_6\text{H}_5]$, a white, crystalline powder with a slightly aromatic odor and taste, practically insoluble in water, but soluble in 5 parts of alcohol and freely soluble in ether, chloroform, and oils. Synthetic or from *Gaultheria* or *Betula*. Dose, 3 to 15 grains (0.2 to 1 Gm.); average, $7\frac{1}{2}$ grains (0.5 Gm.).

Methylis salicylas, U. S. P. (methyl salicylate; an artificial or synthetic oil of wintergreen) $[\text{C}_6\text{H}_4(\text{OH})\text{COOCH}_3]$, a colorless liquid with a strong wintergreen odor, a sweetish strongly aromatic taste, and a specific gravity of 1.18. It is sparingly soluble in water, but dissolves readily in alco-

hol. Dose, 5 to 20 minims (0.3 to 1.3 c.c.). Chiefly used externally.

Salicinum, U. S. P. (salicin) $[\text{C}_{18}\text{H}_{18}\text{O}_7]$, a glucoside obtained from several species of the willow (*Salix*) and poplar (*Populus*), occurring in colorless, silky, crystalline needles, prisms, or a white, crystalline powder, odorless, but with a strongly bitter taste. It is soluble in 21 parts of water and in 71 parts of alcohol, but is insoluble in ether and chloroform. Dose, 10 to 30 grains (0.6 to 2 Gm.).

Oleum betulae, U. S. P., VIII (oil of betula; oil of birch), a volatile oil obtained by maceration and distillation from the bark of the sweet birch, *Betula lenta*. Consists mainly of methyl salicylate. Dose, 5 to 20 minims (0.3 to 1.3 c.c.). Chiefly used externally.

Oleum gaultheriae, U. S. P., VIII (oil of gaultheria or wintergreen), a volatile oil distilled from the leaves of *Gaultheria procumbens*, consists mainly of methyl salicylate. Dose, 5 to 20 minims (0.3 to 1.3 c.c.). Chiefly used externally.

Spiritus gaultheriae, U. S. P., VIII (spirit of gaultheria), made by mixing 5 parts by volume of oil of gaultheria with 95 parts of alcohol. Dose, 30 minims (2 c.c.).

Bismuth subsalicylate, physostigmine salicylate, quinine salicylate, and caffeine sodiosalicylate (N. F.) are described in the articles on Bismuth, Physostigma, Cinchona, and Caffeine, respectively.

Among the salicylic preparations recognized in the National Formulary are:—

Lithii salicylas, N. F. (lithium salicylate) $[\text{C}_6\text{H}_4(\text{OH})\text{COOLi}]$, a white or grayish-white powder with a sweetish taste, deliquescent in a

moist atmosphere. It is freely soluble in water and alcohol. Dose, 5 to 20 grains (0.3 to 1.3 Gm.).

Elixir lithii salicylatis, N. F. (elixir of lithium salicylate). Dose, 2 fluidrams (8 c.c.), containing 10 grains (0.6 Gm.) of lithium salicylate.

Elixir sodii salicylatis, N. F., similar to the preceding.

Glycerogelatinum acidi salicylici, N. F. (glycerogelatin of salicylic acid), containing 10 per cent. of the acid. Used locally, being melted by gentle heating and applied with a camel's hair brush.

Liquor antisepticus, N. F. (antiseptic solution, Lister), containing 30 per cent. of alcohol, 2.5 per cent. of boric acid, 0.12 per cent. of methyl salicylate and of sodium salicylate, 0.6 per cent. of sodium benzoate, 0.5 per cent. of eucalyptol, 0.1 per cent. of thymol, and 0.03 per cent. of oil of thyme. Dose, 1 fluidram (4 c.c.). Chiefly used locally.

Liquor antisepticus alkalinus, N. F. (alkaline antiseptic solution), containing 15 per cent. of glycerin, 3.2 per cent. of potassium bicarbonate and of sodium borate, 0.8 per cent. of sodium benzoate, 0.04 per cent. of oil of gaultheria, and 0.02 per cent. of thymol, of eucalyptol, and of oil of peppermint, colored purplish red with cudbear; 6 per cent. of alcohol. Used locally, diluted with 2 to 5 parts of warm water.

Pasta zinci, N. F. (Lassar's zinc or zinc-salicyl paste), containing 2 per cent. of salicylic acid, with zinc oxide. Used externally.

Pulvis antisepticus, N. F. (soluble antiseptic powder), a mixture of powdered boric acid, 86.6 per cent.; zinc sulphate, 12.5 per cent.; salicylic acid, 0.5 per cent.; phenol, eucalyptol, menthol, and thymol, of each 0.1 per

cent. Used as dusting powder or in 5 per cent. solution.

Pulvis talci compositus, N. F. (salicylated talcum powder), consisting of salicylic acid, 3 parts; boric acid, 10 parts, and powdered talc, 87 parts. Used as dusting powder.

Mulla acidi salicylici, N. F. (salicylated salve mull or ointment), a 10 per cent. preparation of salicylic acid in benzoinated lard and suet, spread on gauze or mull, to be applied to the skin where penetration by the salicylic acid is desired.

Mulla creosoti salicylata, N. F. (salicylated creosote salve mull), like the preceding, with addition of 20 per cent. of creosote.

UNOFFICIAL PREPARATIONS.

—Among the unofficial salicylic preparations used internally are:—

Acetylsalicylic acid (aspirin) $[C_6H_4O(CH_3CO).COOH]$, occurring in colorless, crystalline needles with an acidulous taste, soluble in 100 parts of water, and freely soluble in alcohol. Salicylic acid is liberated from it in the intestine. It causes less sweating than the ordinary salicylates. Dose, 5 to 30 grains (0.3 to 2 Gm.).

Diaspirin (succinic ester of salicylic acid) $[C_2H_4(COO.C_6H_4COOH)_2]$, a white powder with slightly acid taste, sparingly soluble in water, easily soluble in alcohol. Dose, 5 to 30 grains (0.3 to 2 Gm.). Stronger than novaspirin, but has marked sudorific power (Klaveness).

Novaspirin (methylene citrylsalicylic acid), a white, crystalline powder with a faint acidulous taste, scarcely soluble in water, freely soluble in alcohol. Contains 62 per cent. of salicylic acid. Dose, 10 to 30 grains 0.6 to 2 Gm.). Weaker in

action than the preceding, though better tolerated by sensitive patients.

Salicylosalicylic acid (diplosal; salicylic ester of salicylic acid) $[C_6H_4(COO)OH.COOH.C_6H_4]$, a colorless, tasteless powder, almost insoluble in water, readily soluble in dilute alkalis. It yields 1.07 times as much of the salicyl group in the organism as salicylic acid itself, owing to the fact that in its molecule two molecules of salicylic acid are present in condensed form, one molecule of water (H_2O) having been eliminated. It is unirritating to the stomach and is absorbed from the intestine. Dose, 5 to 20 grains (0.3 to 1.3 Gm.).

Antipyrin salicylate (salipyrin) $[C_{11}H_{12}N_2O.C_6H_4OH.COOH]$, a white, crystalline powder, slightly sweetish, soluble in 200 parts of water, readily soluble in alcohol. Acids liberate salicylic acid from it, and alkalis, antipyrin. Dose, 5 to 15 grains (0.3 to 1 Gm.).

Ferric salicylate (iron salicylate) $[Fe_2(OOC(OH)C_6H_4)_3]$, a reddish-brown or violet-gray powder, sparingly soluble in water, readily soluble in a solution of potassium bicarbonate. Dose, 3 to 10 grains (0.2 to 0.6 Gm.).

Guaiacol salicylate (guaiacyl salicylate; guaiacol-salol) $[C_6H_4.OH.COOC_6H_4.OCH_3]$, a white, crystalline, tasteless powder, insoluble in water, soluble in alcohol. Decomposed by alkalis. Analogous to phenyl salicylate (salol). Dose, 5 to 15 grains (0.3 to 1 Gm.).

Naphthol salicylate (betol; naphthalol; betanaphthyl salicylate; naphthol-salol) $[C_6H_4.OH.COOC_{10}H_7]$, a white, shining, tasteless, crystalline powder insoluble in water, with difficulty soluble in alcohol. Decomposed when treated with alkalis. Split up

in the intestine by the pancreatic juice and intestinal secretions. Dose, 4 to 8 grains (0.25 to 0.5 Gm.).

Quinine salicylate (saloquinine; salicyl quinine), a white, crystalline powder, tasteless, insoluble in water, moderately soluble in alcohol, and containing 73.1 per cent. of quinine. Dose, 5 to 30 grains (0.3 to 2 Gm.).

Santalol salicylate (santyl; santalyl salicylate), a yellowish oil with faint balsamic odor and taste, soluble in about 10 parts of alcohol. Split up in the intestines, yielding 60 per cent. of santalol (santal oil). Dose, 8 minims (0.5 c.c.).

Unofficial salicylic preparations used externally: Ethyl salicylate (sal ethyl) $[C_6H_4.OH.COOC_2H_5]$, a colorless, volatile fluid with a pleasant odor and taste, insoluble in water, soluble in alcohol. Analogous to methyl salicylate. May be used both externally and internally.

Mesotan (methyl-oxymethyl salicylate; ericin) $[C_6H_4.OH.COOC(CH_2.O.CH_3)]$, a yellowish, faintly aromatic, oily fluid, but little soluble in water, soluble in alcohol, miscible with oils. To be applied, diluted with an equal volume of olive oil, to the skin, avoiding friction, as mesotan is somewhat irritating.

Salophen (acetylparamidophenol salicylate), a white, tasteless, crystalline powder, almost insoluble in cold water, freely soluble in alkaline solutions, and in alcohol. It contains 51 per cent. of salicylic acid. It is broken up in the intestine, liberating salicylic acid, and acetylparamidophenol. Dose, 5 to 20 grains (0.3 to 1.3 Gm.). Used externally in a 10 per cent. ointment in itching skin affections.

Spirosal (monoglycol salicylate) $[C_6H_4.OH.COOC(CH_2.CH_2.OH)]$, an

oily, almost odorless fluid, soluble in about 110 parts of water, freely soluble in alcohol. To be applied to the skin undiluted, mixed with 3 parts of alcohol or 8 parts of olive oil, or in a 50 per cent. petrolatum ointment. It is absorbed through the skin without irritation and sets free salicylic acid in the tissues.

INCOMPATIBILITIES.—Salicylates are incompatible with mineral acids, which set free the relatively insoluble salicylic acid by combining with the basic element. They are also incompatible with sweet spirit of niter, with lime-water, and with quinine salts, ferric salts, lead acetate, and silver nitrate in solution, as well as with sodium phosphate in powder form. Mixtures of quinine and acetylsalicylic acid are dangerous, developing after a time the poisonous substance quinotoxin, which resembles digitoxin in its action. This toxic change develops even more readily in a mixture of cinchona and acetylsalicylic acid, and also in elixirs and syrups containing quinine in acid solution.

MODES OF ADMINISTRATION.

—Salicylic acid, which is irritating to mucous surfaces, should always be given in solution, preferably with potassium citrate or acetate, or ammonium acetate or phosphate, all of which increase its solubility in water. Or, it may be given in a syrup, flavored with compound spirit of lavender, or in elixir of orange. Preferable to the acid, however, is sodium salicylate, which, though less irritating, should likewise be given in solution. The salt may, for example, be prescribed in 5 parts of *Aqua menthae piperitæ* or *Aqua gaultheriæ*, with a little glycerin added to reduce irri-

tation, and an appropriate amount ordered mixed with some sparkling water at each dose. An effervescent preparation may be secured by prescribed equal amounts of salicylic acid and sodium bicarbonate in powders, to be dissolved in water and taken when the effervescence begins to subside. Small doses of sodium salicylate may be given in capsules, to be taken only during or after meals. Strontium salicylate is preferred by some to the sodium salt. Oil of gaultheria (wintergreen) or methyl salicylate may also be substituted for it, given in elastic capsules during or after meals.

The co-operative investigation of the effects of synthetic sodium salicylate and sodium salicylate prepared from natural sources, reported by Hewlett, and based on about 230 separate observations, showed that, from the clinical standpoint there is no essential difference between the two varieties of the drug. According to Pulliam, gastric irritation by sodium salicylate may be due to deterioration, moisture gradually decomposing the salt with liberation of sodium hydroxide and salicylic acid.

Where sodium salicylate given as above described is badly tolerated by the patient, resort may be had to such preparations as acetylsalicylic acid, salophen, diaspirin, and novaspirin, which liberate the salicyl group only in the intestine (and therefore have the disadvantage of acting more slowly and often less powerfully), or to salicin, given in generous dosage. Or, the cutaneous, rectal, hypodermic, or intravenous routes of administration may be partly or wholly relied on.

For application to rheumatic joints

methyl salicylate or oil of gaultheria is generally used, either undiluted, on absorbent cotton or rubbed in small amounts, or diluted with an equal part of olive oil or 2 or more parts of petrolatum, chloroform liniment, or soap liniment. To prevent evaporation of the oils, oiled silk or some other impervious covering may be used. Where these oils are not at hand, absorption of salicylic acid itself may be secured by rubbing in for a few minutes a tablespoonful of a mixture of 1 part of the acid in 5 parts of alcohol and 10 parts of castor oil (Cullen), or an ointment composed of salicylic acid and oil of turpentine, of each 1 part, and hydrated wool-fat, 8 parts (Bracken). The efficiency of either of these methods is shown by the disappearance of joint pain and appearance of the drug in the urine within a few minutes. Other local uses of salicylates are described in the section on THERAPEUTICS.

For rectal administration of sodium salicylate the following formula, recommended by Crouzet, may be employed:—

R Sodii salicylatis ℥ss (15 Gm.).
Acacia pulveris ℥j (4 Gm.).
Lactis f℥iv (120 Gm.).
 Fiat mistura.

The mixture contains 30 grains (2 Gm.) of sodium salicylate to the tablespoonful, is well tolerated, and can be given *ad libitum*, according to the requirements of the case, with a glass syringe or the ordinary rubber enema bulb.

Intrarectal administration of sodium salicylate recommended in refractory cases of **acute** and **subacute rheumatism** from experience in 125 cases. A cleansing soapsuds enema is given and followed immediately

after it acts by the salicylate enema, given with the Davidson syringe and a rectal tube inserted 6 to 8 inches. The dose varies with the weight and sex and the severity of the case. The first adult dose in men is usually from 8 to 10 Gm. (2 to 2½ drams), in women 6 Gm. (1½ drams). The drug to be given is incorporated in 120 to 180 c.c. (4 to 6 ounces) of plain or starch water, with the addition of 1 to 1.5 Gm. (15 to 23 ounces) of opium tincture. The dose may be repeated within twelve hours, but usually a daily enema suffices, with doses increasing perhaps from 30 to 50 per cent. daily until the limit of tolerance is reached. The largest daily dose given was 24 Gm. (6 drams). The only symptoms of salicylism usually appearing were tinnitus and excessive perspiration. The ready absorption was shown by a strong ferric chloride reaction in the urine within thirty minutes. It would seem that the greatest absorption of the drug is within twelve hours. L. G. Heyn (Jour. Amer. Med. Assoc., Sept. 19, 1914).

The hypodermic and intravenous routes have been availed of, with good results, by Siebert and by Mendel, Rubens, and Conner, respectively.

Intravenous injection of salicylates strongly recommended. The preparation used consists of:—

Sodium salicylate 2 dr. (8 Gm.)
Caffeine sodiosalicyl. ½ dr. (2 Gm.).
Sterile water 1½ oz. (45 c.c.).

One-half dram (2 c.c.) is injected twice a day. As the result, joint pains and exudates disappear even where ordinary salicylate treatment fails. A single dose causes marked improvement. None of the unpleasant actions of salicylates are encountered. Cases which do not react are not rheumatic. This is the most certain method of diagnosing the exact nature of doubtful rheumatic cases, especially in diagnosing early tuberculous and rheumatoid arthritis

from true rheumatic cases. F. Mendel (Münch. med. Woch., p. 165, 1905).

The writer injects 10 c.c. (2½ drams) of a 20 per cent. sterilized solution of sodium salicylate per 100 pounds of body weight for **acute rheumatic infections of joints, heart, pericardium and pleura**. He first uses a hypodermic injection of cocaine and fifteen minutes later injects in the same spot the sodium salicylate. The dose is repeated every twelve hours. In severe cases with multiple lesions 15 c.c. (4 drams) to each 100 pounds of body weight is advised. Within three hours after the first injection, pain, fever, joint stiffness and pulse rate diminish. This improvement continues if the injections are repeated every twelve hours, but if omitted the conditions grow worse.

In chronic cases, 10 c.c. (2½ drams) per 100 pounds of body weight of the following oily solution are injected every twenty-four hours: Salicylic acid, 10 Gm. (2½ drams); sesame oil, 80 Gm. (2¾ ounces); pure alcohol, 5 Gm. (1¼ drams); and gum camphor, 5 Gm. (1¼ drams). This is sterilized before the alcohol is added. It must not be exposed to the air, as the alcohol will evaporate and the salicylic acid precipitate. The effect in chronic cases is more rapid when multiple localizations of the rheumatic process exist than when one joint is affected. In the former, pain and stiffness usually improve after the first injection; in the latter, after the third. Addition of camphor (5 to 20 per cent.) was found beneficial in stimulating the heart when the pericardium or endocardium was involved. With this method there is entire absence of the toxic symptoms seen when salicylates are given by mouth. Siebert (Med. Rec., Mar. 11, 1911).

The rapidity of absorption of sodium salicylate when given subcutaneously is about the same as by other routes, but its concentration in the blood does not reach one-half of

that when it is given intramuscularly. Sodium salicylate disappears from the blood in ten hours when given subcutaneously; if given per os it is present in the blood after twenty-four hours. E. Levin (Deut. med. Woch., Dec. 19, 1912).

Administration of sodium salicylate by intravenous injections is safe, painless, and easily performed. The drug seems to have a much more pronounced analgesic effect than when given by mouth. The solution for injection is made by dissolving 10 Gm. (2½ drams) of chemically pure crystalline sodium salicylate in 50 c.c. (1¾ ounces) of distilled water, freshly sterilized by boiling. In most cases the dose has been either 15 or 20 grains (1 or 1.3 Gm.) and the injections given at twelve- or eight-hour intervals over a period of three to six days. Occasionally, in robust men, as much as 30 grains (2 Gm.) have been given at a time, and as much as 120 grains (8 Gm.) given in the first twenty-four hours without any unpleasant effects. The field of indication for the intravenous method includes cases in which the drug is not well borne by the stomach; those which show little or no improvement under the usual methods and, possibly, cases of severe **rheumatic inflammation of the eye**. Conner (Med. Record, lxxxv, 323, 1914).

Case of a man of 25 with extremely severe febrile **rheumatism** involving all the joints, with myocarditis and dyspnea; the stomach being absolutely intolerant for the salicylates. The writer gave an intravenous injection of 6 c.c. (1½ drams) of a mixture of 5 Gm. (1¼ drams) sodium salicylate and 0.25 Gm. (4 grains) caffeine in 25 Gm. (6 drams) distilled water. The injection was repeated daily for six days, increasing the amount from 1.2 to 2 Gm. (20 to 32 minims). By the fourth day the man was able to sit up, with normal temperature, pulse 84, and no further precordial distress. Cernadas (Semana Medica, Dec. 23, 1915).

Phenyl salicylate (salol), in its usual dosage of 5 or 7½ grains (0.3 or 0.5 Gm.) every three or four hours, exerts but little of the effect of salicylates and rather acts like phenol, which it gives off in the intestinal tract. Large doses of phenyl salicylate are, as a rule, to be avoided, as they may induce symptoms of phenol poisoning, and darken the urine. It may be given in capsules, in tablets, or combined, for example, with bismuth salts, in powders. It is almost insoluble in the gastric juice, and does not irritate the stomach.

CONTRAINDICATIONS.—Salicylates are contraindicated except sometimes when used for local purposes, in middle-ear disease, and in conditions associated with impaired renal functioning, as in pregnancy and chronic nephritis. Albuminuria is a contraindication, except in renal disturbance of rheumatic origin, though in infections of the urinary tract phenyl salicylate is used. Salicylates should not be administered to pregnant women who have a tendency to abort, nor in women with metrorrhagia or menorrhagia. Where there is circulatory depression, some degree of caution as to the dosage of salicylates is required.

Prolonged administration of salicylates in large dosage is unwise, causing debility, anemia, and a tendency to hemorrhage from the mucous membranes.

PHYSIOLOGICAL ACTION.—

Externally, salicylic acid is an irritant, especially to mucous membranes. Carefully applied to the skin it is capable of softening the epidermis or accumulations of horny epithelium without inducing inflammation. It also tends to arrest local sweating

and to promote the growth of normal skin in chronic skin affections. It is an antiseptic, stronger than acetanilide and rivalling phenol, over which it has the advantage of not volatilizing. The salts of salicylic acid are less irritating than the free acid, and also much less strongly antiseptic. The liquid salicylates, such as methyl salicylate and the oils of wintergreen and birch, are, however, useful as counterirritants.

General Effects.—*Nervous System.*

—The chief nervous effects of salicylates is manifest in relief from pain, probably due, as in the case of acetanilide and its congeners, either to constriction of vessels *loco dolenti* or to direct depression of the sensory nerve-cells in the optic thalami.

Circulation.—Small doses, if anything, slightly raise the blood-pressure (chiefly by central vasoconstriction) and accelerate the heart. Large doses directly depress the heart. The skin-vessels are dilated by all doses. According to some the number of leucocytes in the blood shows a marked increase, returning to normal, however, after a single dose, within two hours.

Alimentary Tract.—Many of the salicylates, especially the free acid, act as irritants in the stomach. Acetylsalicylic acid, phenyl salicylate (salol) and salicin, however, may not, passing through the stomach unchanged and only setting free the salicyl group in the intestine. Salicylic acid tends to arrest ferment action, interfering, therefore, with the digestive processes. It is claimed that intestinal putrefaction can be reduced with it; and, according to some, large doses of salicylates stimulate the formation of bile.

SALICYLIC ACID, THE SALICYLATES, AND SALICIN (SAJOUS).

Temperature.—Salicylates lower the temperature where there is fever, like antipyrin, but act less strongly. The effect is, at least in part, due to peripheral vasodilatation and sweating, which increase heat loss. A direct action on the heat centers has not as yet been proved to occur.

Metabolism.—Augmented destruction of protein is caused by the salicylates, as shown by a distinct increase in the output of urea, uric acid, and sulphur-bearing compounds in the urine.

The increased output of uric acid following salicylate medication is due to a lowered threshold value of the kidney, not only for uric acid, but in all probability for other waste products as well. Such being the case, it may well be that the beneficial effects resulting from the use of salicylates in acute rheumatic fever may, in part at least, be due to a power possessed by this class of drugs of increasing kidney permeability, thereby facilitating the rapid and more or less complete excretion of the toxins which produce symptoms of these diseases. Denis (*Jour. Pharmacol. and Exper. Therap.*, Oct., 1915).

Absorption and Elimination.—Salicylates are rapidly absorbed from the stomach and duodenum, and circulate in the blood as salicylates of the alkalies. Excretion is also rather rapid, and takes place chiefly through the kidneys, which are irritated by large doses and sometimes react, even after moderate doses, by a diuresis. The chief product in salicylic elimination has long been considered to be salicyluric acid, an inert compound with glyccoll yielding a violet-red color with ferric chloride. Studies by Hanzlik (1915), however, cast doubt upon the elimination of salicyluric acid in man, products free of glyccoll, and pre-

sumed to be in part an impure salicylic acid, being alone found. Small amounts of salicylates ingested are eliminated with the bile, sweat, and mammary secretion.

UNTOWARD EFFECTS AND POISONING.—Overdoses of salicylic preparations produce symptoms simulating cinchonism, viz., a feeling of fullness in the head, tinnitus aurium and, perhaps, slight dizziness. Other signs of overdosage are gastric irritability, nausea and vomiting; headache; mental dullness and apathy, and impairment of hearing or vision, due either to local circulatory modifications or to degenerative changes induced in the cochlear or retinal nerve-cells or in the optic nerve. After very large doses complete deafness or blindness may occur. According to Drayer, 15 grains (1 Gm.) 4 times a day for a week will often produce deafness lasting four months.

In some cases of salicylism, mental excitation is a feature—the "salicylic jag." The cerebral symptoms are similar to those induced by atropine,—talkativeness and great cheerfulness passing on to delirium with hallucinations and motor restlessness. Delirium is an especially common symptom among drunkards. Mental disturbance may persist a week or more.

A number of patients taking salicylates experienced auditory hallucinations. Long-forgotten memories of certain sounds were aroused: the roar of a certain water-fall, the singing of birds heard in a certain garden, etc. The drug reaching the cells seemed to bridge the gap between unconscious and conscious memories. Seitz (*Correspondenzbl. f. schweizer Aerzte*, Apr. 1, 1909).

Poisonous doses of salicylic acid induce burning in the throat, nausea

and vomiting, sometimes diarrhea; special sense disturbances, sometimes with mydriasis, ptosis, or strabismus; thirst; precordial oppression; feeble heart action and vasomotor weakness; sweating; marked dyspnea; prostration; greenish urine, and occasionally albuminuria, hematuria, or even suppression of urine; coma. Death, when it occurs, is due to respiratory paralysis, and may be preceded by general convulsions.

A girl, aged 10 years, had been suffering from acute rheumatism for three days. Endocarditis developed. A purgative was given and then 15 grains (1 Gm.) of sodium salicylate with double that amount of sodium bicarbonate every four hours, for four days, when the child became delirious and vomited twice. The salicylate was withdrawn and the delirium quickly passed off. On the fourth day after admission the temperature, pulse, and respirations were normal.

Later, the patient again complained of joint pains and salicylates were resumed (7 grains—0.45 Gm.—in water 3 times a day). After two days she again vomited. There was no delirium, but the urine contained sufficient blood to give it a deep-red color. She also complained of severe pain along the left iliac crest, and there was much tenderness in the left renal region. Salicylates being discontinued, the urine was clear in four days, containing neither blood nor albumin, and the pain had also disappeared. The pain was probably a "referred pain" from the kidney. J. D. Marshall (*Lancet*, Feb. 2, 1907).

The dosage of salicylic preparations necessary to induce circulatory depression is relatively large, 20 grains of sodium salicylate, repeated at intervals of two or three hours, rarely having an appreciable action on the pulse and blood-pressure.

The primary effect of salicylates is on the temperature, which drops suddenly owing to increased heat radiation through the dilated capillaries. The resulting depression of the nervous system determines the collapse. These drugs should be given in small doses, frequently repeated, to avoid rapid temperature reduction. Bovisoff (*Roussky Vrach*, Feb. 23, 1913).

Experiments showing that solutions of sodium salicylate gradually deteriorate on standing, the loss being greater in the weaker solutions. About 20 per cent. is destroyed in the body, and 40 per cent. when there is fever, alcoholism, morphinism, or exophthalmic goiter. Hanzlick and Wetzel (*Jour. of Pharm. and Experim. Therap.*, Sept., 1919).

Erythema with edema, intolerable itching and tingling of the skin, and fever, have been caused by large doses of sodium salicylate. Other possible effects are transitory dark-colored spots, ecchymoses, vesicles and pustules.

According to Martinet, sodium salicylate sometimes induces in children symptoms similar to those of diabetic acidosis. **Sodium bicarbonate** in large doses and **catharsis** are advocated in the treatment.

A chronic form of salicylic poisoning has been met with in persons exposed to inhalation of the acid, marked by a subacute inflammation of the air-passages, sometimes with a serious degree edema. In these instances **potassium iodide** is beneficial. Chronic absorption from food or drink preserved with salicylic acid may result in constipation alternating with diarrhea, mental depression, skin eruptions, and albuminuria.

TREATMENT OF POISONING.

—The tinnitus caused by salicylic acid may be relieved by a 20-grain (1.3 Gm.) dose of **sodium bromide**. In

the treatment of salicylism, the giving of large doses of **sodium bicarbonate** has been recommended to hasten elimination of the drug. The treatment of severe acute poisoning is largely symptomatic, **cracked ice** by the mouth and an **ice-bag** or **mustard plaster** over the epigastrium being used to relieve vomiting, **cold compresses** being applied for headache, **veronal** or **opiates** given for the restlessness and delirium, and appropriate **stimulants** for circulatory depression. As in other forms of acute poisoning the stomach should be thoroughly evacuated with the stomach-tube or emetics and, if it seems advisable, a **purge** given to clear the drug from the intestine. For further suggestions as to treatment the reader is referred to the sections on Poisoning in the articles on ACETANILIDE, ACETPHENETIDIN, and ANTI-PYRIN.

THERAPEUTICS.—Salicylic acid and its salts are used for both general and local effects.

General Uses.—As remedies in acute rheumatism, the salicylates hold first rank by reason of the prompt relief of pain, fever and other symptoms of this disease they afford. Various methods of administration have been suggested, some of which are referred to in the article on RHEUMATIC FEVER. Plehn, among others, lays stress on adequacy of dosage, giving even mild cases 15 grains (1 Gm.) of salicylic acid 6 times a day (suspending the remedy at night), until the temperature has remained normal for three days, after which a few 15-grain (1 Gm.) doses are given daily for a week, the patient then remaining in bed three days more, without the remedy. In women the dos-

age is made smaller—often only 5 and sometimes only 3 doses a day at the outset. With this treatment, Plehn observed the development of valvular disease in only 2 out of 319 cases treated. Plehn's dosage, however, seems somewhat excessive from the standpoint of special sense impairment and renal irritation. Sodium salicylate is better tolerated by the stomach than the free acid and may be substituted for it for this reason. Tinnitus should be regarded as a warning signal against large dosage. Homberger advises the combination of sodium bicarbonate (1 or 2 parts) with sodium salicylate, given in solution in a little water, the purpose being to prevent liberation of the more irritating salicylic acid from the salicylate by the hydrochloric acid of the gastric juice, and simultaneously to accelerate absorption of the salicylate by means of the carbon-dioxide gas evolved. He also advises that the drug be given between meals, when there is least acid in the stomach, and not too freely diluted, as a large quantity of fluid will cause it to be retained longer in the stomach. Salicylic treatment in those with sensitive stomachs can likewise be carried out with acetylsalicylic acid (aspirin), which sets free the salicyl group only in the intestinal alkaline medium. Klaveness prescribes this drug in 15-grain (1 Gm.) doses every two or three hours, combined, in persons in whom circulatory weakness is suspected, with 1½ grains (0.1 Gm.) of powdered ergot. In children, Osler is credited with recommending salicin in full doses; Comby praises the action of sodium salicylate in the dosage of 7 grains (0.5 Gm.) a day for each year of the child's age. The

rectal, intravenous, intramuscular, and percutaneous methods of administering salicylates are also available.

Renal irritation from salicylates, manifested in slight albuminuria, sometimes with a few casts, is generally recognized to be a temporary condition, though it may persist for weeks and even be serious where some degree of nephritis already exists. Combination with sodium bicarbonate was found by Glaesgen to obviate renal irritation by the salicylates. Acetylsalicylic acid is held by some to be non-irritating to the kidneys.

In muscular rheumatism, including lumbago, the salicylates are of value in relieving the pain; likewise in the so-called "growing pains." In gonorrheal rheumatism their effect is less marked. The pains of chronic fibrositis are quickly relieved by sodium salicylate combined with antipyrin (Stark). In sciatica and other painful rheumatic nervous conditions the salicylates are also of distinct value. In migraine, a combination of sodium salicylate and potassium bromide, given at the start of the attack, often yields a gratifying result. In rheumatic uveitis and scleritis marked benefit is obtained from 15-grain (1 Gm.) doses of the salicylates, given 4 times a day.

In rheumatic conditions associated with anemia the writer uses the following mixture: In an 8-ounce (240 c.c.) bottle place 1 dram (4 Gm.) of sodium salicylate and dissolve it in about 2 ounces (60 c.c.) of water. Add liquor ferri perchloridi (B. P.) $\frac{1}{2}$ dram (2 c.c.), plus about an ounce (30 c.c.) of water. This produces a dark-purple mixture with a thick, curdy precipitate. Then add 1 dram (4 Gm.) of potassium bicarbonate dissolved in 1 ounce (30 c.c.) of water,

and fill up the bottle to 8 ounces (240 c.c.) with water. The precipitate dissolves on the addition of the potassium solution, and the result is a clear claret-colored mixture of an agreeable taste.

The mixture was found particularly useful in a kind of sore throat apparently of rheumatic origin (primary or secondary) with slight redness and pain, especially on swallowing. H. Drinkwater (Liverpool Medico-Chir. Jour., July, 1911).

For the relief of pain in general, the acetyl preparations of salicylic acid, such as aspirin and diaspirin, seem more efficient than the other preparations. In neuralgia, the pains of tabes dorsalis, and those of peripheral neuritis, these drugs often prove of value. In mild forms of dysmenorrhea, acetylsalicylic acid is a particularly efficient remedy. It may also be used in acute and subacute pelvic cellulitis, salpingitis, ovaritis, and parametritis.

In acute tonsillitis or peritonsillitis, frequently rheumatic in nature, salicylates are considered of value, relieving pain and swelling, shortening the period of illness, and perhaps obviating suppuration if given early. In addition to its internal use, gargling with, *e. g.*, $1\frac{1}{2}$ to 2 drams (6 to 8 Gm.) of sodium salicylate in 6 fluid-ounces (180 c.c.) of peppermint-water (Cheveller), or direct application of a salicylate to the tonsils (Fetterolf), has been advised.

Salicylate of iron recommended in erysipelas and acute tonsillitis. Care should be taken in its preparation, that the iron is added to the sodium salicylate, otherwise the characteristic reddish-brown precipitate does not form.

For adults, the dose generally contains $7\frac{1}{2}$ grains (0.5 Gm.) of sodium salicylate and potassium bicarbonate, and $7\frac{1}{2}$ minims (0.45 c.c.) of the B. P. liquor ferri perchlor. The solution

is of a clear violet color, and is quite palatable, though it may be sweetened if necessary. It is non-depressant, non-constipating, and is a well-marked febrifuge. The feces are colored black.

In erysipelas the mixture acts with the greatest rapidity, cutting short the disease, which never lasts more than 10 days, and in most cases is cured in 3 or 4. After the first few doses, there is a striking alleviation of all pain. The drug is administered every three hours, the treatment being commenced with a purgative, such as calomel. As a rule, within 24 hours the temperature is normal, the disease has ceased to spread, and the patient feels better.

The cases of acute tonsillitis in which salicylate of iron has an excellent action are probably those of streptococcal origin. It acts very quickly; if, after 3 days, there is no marked improvement, it is not worth while continuing. In a recent outbreak of sore throats at a school, the drug was markedly successful in about 50 per cent. of cases.

In cases of erysipelas of great severity, the writer often adds twice the usual amount of iron, which produces a very dark solution but no precipitate, and is much stronger in its action on the disease. M. C. S. Lawrence (Practitioner, Mar., 1913).

In **influenza** or **grippe**, Stark administers the following after a mercurial purge:—

℞ *Sodii salicylatis*,
Potassii bicarbonatisāā gr. x (0.6 Gm.).
Tinctura nucis vomica m℥ (0.6 c.c.).
Aq. chlorof. . . .q. s. ad f℥j (30 c.c.).

M. Sig.: Every two to four hours.

Good results in **pneumonia of influenzal origin**, in that succeeding **measles**, and in **pharyngitis**, **laryngitis**, and **bronchitis**, by local application of a 10 per cent. solution of salicylic acid and of castor oil, respectively, in 90 per cent. alcohol. In the

pneumonic cases a compress moistened with the solution was placed over the entire back, covered with impermeable material, and held in place by a bandage. The dressing was renewed whenever it became dry. A prompt and very favorable influence upon the cough, temperature, pulse and respiration was noted. L. G. Boutchinskaja-Yourchevskaja (Semaine méd., Sept. 11, 1912).

In **acute coryza**, the same author recommends the following:—

℞ *Sodii salicylatis* gr. x (0.6 Gm.).
Spiritus ammoniæ aromatici f℥ss (2 c.c.).
Tinctura belladonnæ foliorum m℥ (0.3 c.c.).
Aq. chlorof. . . .q. s. ad f℥j (30 c.c.).

M. Sig.: Every four hours.

Stark has also found the drug useful in **mumps**, in **puerperal fever**, and in "**bilious headache**," in the latter condition combined with potassium bromide.

In **gout**, salicylic acid, though inferior to colchicum, may be of value for a short time. It was found by Fine and Chace (1915), to increase the elimination of uric acid, sometimes even more than atophan. In **phosphaturia**, sodium salicylate will clear up the urine and arrest the reflex nerve pains.

In **pleural effusion**, 30 to 60 grains (2 to 4 Gm.) of sodium salicylate are credited with some power to promote absorption of the effusion.

In **diabetes mellitus**, von Noorden considers sodium salicylate the most useful of the drugs, with the exception of codeine and other nerve sedatives.

Chibret found sodium salicylate in a daily dosage of 1 dram (4 Gm.) of some value in bringing symptomatic relief in **exophthalmic goiter**. Monae-Lesser observed that the administra-

tion of 3 or 4 15-grain (1 Gm.) doses of sodium salicylate in **renal** and **hepatic colic** assisted the action of opiates and, by relaxing the channels, favored passage of the stones. The same author advises the giving of sodium salicylate by the mouth or rectum (15 grains every three hours) in **cystitis** and **acute prostatitis**, and treats **acute ascending cellulitis** of the extremities by administering this salt internally and applying locally an ointment consisting of magnesium carbonate, resorcinol, and lanum.

The value of phenyl salicylate (salol) as an antiseptic acting in the urinary passages is well known. A dosage exceeding 30 grains (2 Gm.) a day is rarely necessary, and is, in fact, likely to produce untoward results. The drug should, therefore, ordinarily not be employed in acute rheumatism. It is of value, however, in **gonococcal urethritis**, in **pyelitis**, and in certain forms of **cystitis**.

For purposes of intestinal antiseptics, phenyl salicylate is likewise the most useful drug of this group, having the added advantage of not upsetting the stomach. **Diarrhea** due to an acute infection or toxic food is frequently arrested by phenyl salicylate, which may be given alone in 5- or 7½-grain (0.3 to 0.5 Gm.) doses in capsules or tablets or with 2 or 3 parts of bismuth subnitrate in powders. Bismuth subsalicylate may be substituted for the last-named combination, but its antiseptic effect is far inferior, owing to the absence of phenol.

Local Uses.—In **subacute** and **chronic eczema**, salicylic acid often gives excellent results, more particularly in the "rubrum" and squamous varieties, or where there is consider-

able fissuring, *e.g.*, on the **dorsa** of the hands and in the **flexures** of the joints. An ointment containing 4 to 8 per cent. of salicylic acid in either petrolatum, hydrated wool-fat, or zinc-oxide ointment should be used in such cases. In **eczema** of the face, in the **weeping** stage, or in not too extensive **erythematous** or **pustular eczema**, the following is of value: Salicylic acid, 5 to 10 grains (0.3 to 0.6 Gm.); powdered starch and zinc oxide, of each 2 drams (8 Gm.); petrolatum, ½ ounce (15 Gm.).

In **psoriasis** salicylic ointments are of value, especially to remove the scales. Crocker recommends salicylates internally in extensive but recent **psoriasis guttata**. In **pityriasis capitis** with marked desquamation Cantrell found useful a weak emulsion of salicylic acid in water with mucilage of acacia. **Pityriasis rubra** also improved under mild salicylic ointments, and mild cases of **ichthyosis** were likewise benefited. **Lentigo** was usually cured by strong salicylic applications. Indurated, **papular acne** was greatly improved, and **seborrhea** of the scalp, chest, or nasal orifices favorably influenced. Among the other skin conditions in which salicylic acid has proven of use are **erythema multiforme**, **erythema nodosum**, **lupus erythematosus**, and **miliaria**. **Erythema** following horseback riding, or **intertrigo**, may be relieved with a 2 per cent. salicylic ointment.

The itching of **urticaria** may be allayed with a dusting powder composed of salicylic acid, 1 part; zinc oxide, 3 parts, and powdered starch, 6 parts. In **chronic urticaria**, the internal use of 20-grain (1.3 Gm.) doses of sodium salicylate is also recommended. For **pruritus** of the vulva

and anus the following may be used: Salicylic acid, white wax, of each 2 drams (8 Gm.); cacao butter, 5 drams (20 Gm.); oil of nutmeg, $\frac{1}{2}$ dram (2 c.c.).

In ordinary ringworm (*tinea circinata*) a solution of 10 grains (0.6 Gm.) of salicylic acid in $\frac{1}{2}$ ounce (15 Gm.) of collodion is rapidly curative where the condition is not too long standing.

In hyperidrosis of the feet, hands, or axillæ, a mixture of equal parts of powdered salicylic acid and talc or starch will remove odor and tend to arrest the trouble.

Where there is a tendency to occlusion of the ducts of sweat-glands or other follicles, mild salicylic ointments are of value to prevent or overcome blockage.

For corns, a saturated solution of salicylic acid in collodion, the creosote salicylic plaster mull of Unna (6 to 10 parts of the acid and 1 to 2 parts of creosote spread upon gutta-percha), or the following combination, may be relied on to produce the desired softening.

R *Acidi salicylici* gr. x (0.6 Gm.).
Olei terebinthinæ rectificati m v (0.3 c.c.).
Acidi acetici glacialis m ij (0.12 c.c.).
Cocainæ hydrochloridi gr. ij (0.12 Gm.).
Collodii m c (6 c.c.).

M. Sig.: Apply locally.

For removal of warts, similar preparations are advantageously used. A mixture of salicylic acid and lactic acid, of each $\frac{1}{2}$ dram (2 Gm.) in 1 fluidounce (30 c.c.) of flexible collodion may be applied to the summit of the wart with a match-stick night and morning for five or six days. Soaking the part in water will then cause detachment of the slough. If

any part of the growth remains, the treatment may be resumed and continued for three days. This, however, is not often necessary.

Soft chancres and venereal sores may be dressed with the following ointment: Salicylic acid, 20 grains (1.3 Gm.); alcohol, 45 minims (3 c.c.); benzoated lard, 2 ounces (60 Gm.). As a dusting powder, 1 part of the acid may be mixed with 8 parts of powdered starch or chalk.

A 1:1000 solution of salicylic acid has been employed as a nasal douche in chronic ozena. In chronic middle-ear suppuration Foltz has used with satisfaction insufflations of 1 part of powdered salicylic acid with 6 parts of boric acid.

Thiersch's solution, a non-toxic fluid available for general antiseptic purposes, consists of salicylic acid, 1 part; boric acid, 6 parts; dissolved in water, 500 parts.

Application of dry powdered salicylic acid to suppurating and infected wounds gives excellent results, causing liquefaction and prompt disappearance of the scab or slough, leaving a clean, bright-red, granulating surface which heals rapidly. Offensive odors disappear within 24 hours. It causes no pain or irritation. Doses of 3 to 5 grains (0.2 to 0.3 Gm.) in milk or bismuth suspension give favorable results in typhoid fever. *In vitro*, 0.2 to 0.5 per cent. of the acid inhibits or destroys Shiga's dysentery bacillus, the *B. typhosus*, staphylococcus, *Streptococcus pyogenes*, *B. diphtheria*, pneumococcus, and *B. tetani*. A. Wilson (Brit. Med. Jour., Feb. 20, 1915).

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SALINE INFUSION. See INFUSIONS, SALINE.

SALIVARY GLANDS, DISEASES OF.—XEROSTOMIA (DRY MOUTH).—Symptoms.—

Arrest of the salivary or buccal secretions was first studied by Hutchinson, in 1887. Since then about 40 cases have been recorded. The tongue appears red, devoid of epithelium, cracked, and absolutely dry. The inside of the cheek and the hard and soft palates are also dry, and the mucous membrane is smooth, shining, and pale (Seifert). Diminution in the nasal and lachrymal secretions has also been noted, as well as dryness of the skin and crumbling or falling out of the teeth. The urine is normal. The general health and the digestion are unimpaired, but swallowing and articulation are difficult, owing to the absence of moisture. The disease usually reaches its greatest intensity rapidly, and may then remain without change for years. It usually persists until the patient dies.

Etiology and Pathology.—Xerostomia is almost always met with in women, and about one-half of the cases occur in subjects past 50 years of age. It sometimes follows a shock. It is usually ascribed to defective nerve-function, many patients showing distinct evidences of nervous disturbance: hysteria, hypochondria, anuria, etc. In some it appears to result from mere arrest of function without impairment of the general health. In 36 cases studied by A. J. Hall the state of the salivary glands and ducts was as follows: In 8 cases the parotids were enlarged, either equally or unequally; in 3 they were tender and painful; in 4 they were not so, and in 1 the gland ulcerated through into the mouth. In

5 cases enlargement varied from time to time; in 1 of these enlargement was most marked at the menstrual period. With 1 exception, other neighboring salivary glands were not enlarged.

Treatment.—**Pilocarpine** has been used with some success in these cases, but the condition usually recurs. Blackman employs the drug in $\frac{1}{20}$ - to $\frac{1}{10}$ -grain (0.003 to 0.006 Gm.) doses, in a gelatin lamella, which is placed on the tongue and moistened with water.

PTYALISM.—Excessive secretion of saliva occurs as a symptom of rabies, the various forms of stomatitis, especially the mercurial form, dentition, various gastric disorders, etc.; but as an idiopathic disorder it is rarely met with. It is often observed in neurotic subjects, especially children, and usually disappears after a few years, when the development of the subject has become equalized. It occasionally attends pregnancy (*q. v.*), and may occur during menstrual periods and various febrile disorders, particularly smallpox. The effects of pilocarpine, mercury, iodine, copper, and other agents in causing ptyalism are well known.

Treatment.—The general health requires attention, the idiopathic form being in reality a manifestation of debility. **Weak astringent washes**, or a saturated solution of **potassium chlorate**, may be tried. The **galvanic current**, the positive pole being applied in the mouth while the latter is full of water, the negative pole being placed over the thyroid cartilage, may prove of value if used daily.

SALIVARY CALCULUS.—Salivary concretions of various sizes sometimes form in the parotid gland

and its duct,—Stenson's,—causing inflammation of the organ, retention of saliva, and enlargement of the organ. The majority of calculi, however, are found in Wharton's duct: the duct of the maxillary gland. Foreign bodies—which, as shown by Desmartin, frequently enter Wharton's duct—often act as nuclei. Klebs and Waldeyer contend that masses of micro-organisms are the most common causes of salivary calculi, the phosphates and carbonates of lime, magnesia, soda, etc., being deposited around them. The stones may become as large as eggs, and multiple, and are occasionally faceted. In some cases the inflammatory phenomena proceed to abscess-formation, and, spontaneous rupture taking place, a salivary fistula is formed. In the case of Stenson's duct the opening is opposite the second molar of the upper jaw. Wharton's duct opens beneath the tongue, under the frenum. Both openings can be penetrated with a probe, or a fine needle may be inserted into the mass and its contents thus recognized.

Treatment.—It is sometimes possible to remove a small calculus through the canal; but, as a rule, it is necessary to thoroughly anesthetize the part with cocaine and to **remove the mass by an incision** through the oral tissues.

TUMORS OF THE SALIVARY GLANDS.—Cysts.—Cystic dilatation of the parotid and maxillary glands or of their ducts is occasionally observed, as a result of a superficial inflammatory process or of cicatricial stenosis of the orifices. In a case noted by Stubenrauch the growth—a parotid cyst—was found studded with tubercular nodules. Stenson's

duct may become inflated with air through forcible air-pressure—such as that accompanying the playing of wind-instruments, glass-blowing, etc.—and simulate a cyst.

In many of these cases it is necessary to **remove the sac wall after evacuating the contents by incision.**

Tumors of the Parotid.—Tumors of the parotid are often the result of implication of the glandular tissues in neoplasms of neighboring structures. They may arise in the gland itself, however. Almost any variety of growth, especially adenoma, fibroma, chondroma, myxoma and the malignant varieties—sarcoma and carcinoma—may be encountered.

The **removal of the entire gland** for large malignant growths necessitates a grave operation, owing to the proximity and frequent involvement of the external carotid, the internal jugular vein, and other important vascular and nervous structures. For this reason, large malignant neoplasms are removed with difficulty and often imperfectly. An old and good rule in such cases is to **remove movable growths: i.e., those which are not firmly fixed to the underlying tissues.** **Benign tumors** can usually be successfully **extirpated.** After the first free incision is made the mass should as much as possible be removed by the fingers. The facial nerve and the temporomaxillary are thus less exposed to injury.

Tumors of the Maxillary Gland.—This gland may be the seat of any of the forms of tumor met in the parotid, but, like it, is often involved in growths that develop in the neighboring structures, especially carcinoma of the inferior maxillary. The

mass usually projects beneath the jaw. The **removal** is not as difficult as is the case of tumors of the parotid, the facial and lingual arteries, which are easily tied, and the lingual and hypoglossal nerves, which can easily be avoided, offering no obstacle to a thorough operation. Here, also, however, it is always best to use the fingers to decorticate, as it were, the growth after incision of the superficial tissues.

PAROTITIS.—Inflammation of the parotid gland.

Definition.—Parotitis is usually an infectious disease (*infectious parotitis*), but it may result from injury (*traumatic parotitis*) or from the extension of inflammatory or malignant processes in adjacent tissues (*irritative parotitis*).

TRAUMATIC PAROTITIS.—Inflammation of the parotid gland may certainly result from injuries of sufficient severity to cause an effusion of blood into the gland or the tissues surrounding it. It may also result from burns or the application of caustics. While micro-organisms may take part in the process, the condition is quite different from infectious or septic parotitis. Unless infected with septic germs, suppuration is not common.

INFECTIOUS PAROTITIS.—Two forms of parotitis occur as the direct result of germ invasion: 1. Mumps; epidemic parotitis. 2. Metastatic, symptomatic, suppurative, or septic parotitis.

The writers observed 38 cases in which extreme swelling and pain in one or both parotid glands had followed typhus or relapsing fever at a French hospital in Roumania in 1917. The parotitis seemed to be more common after typhus, and gangrene from arteritis after relapsing fever,

but these complications occurred in some of both. They recall that it is due to secondary infection, streptococci predominating. Bonnet and de Nabias (*Lyon Chir.*, Mar.-Apr., 1919).

1. **Mumps.**—Mumps is an acute, infectious, contagious inflammation of one or both parotid glands, or other salivary glands, usually occurring epidemically. Although inflammation of the parotid glands may be caused by various germs, the disease commonly known as mumps gives every indication of being a specific disease. A period of incubation, the method of invasion, and the definite course pursued mark the disease as a specific fever. No specific germ, however, has as yet been discovered. Several micro-organisms have been isolated and held by their discoverers to be the causative germ of the disease. The last of these at the present writing was a micrococcus described by Merelli, of Pisa, to which he gave the name of *Micrococcus tragenus*. The correctness of this view has not yet been confirmed by other observers.

In 1908 Granata concluded that the virus of mumps may be of the filterable type. However, neither he nor Nicolle and Conseil, who injected bacteria-free fluid from the parotids in cases of human parotitis, reproduced the disease satisfactorily.

The writer succeeded in reproducing the chief organic lesions of parotitis in animals by means of filtered extracts of saliva from human patients. The active agent in the infectious saliva was found to be neutralized by the serum of an animal that had survived the injection of testicular and parotid emulsions, while the serum of a normal animal had no such power. Various facts suggested the presence of a minute filterable virus. Martha Wollstein (*Jour. Exper. Med.*, xxxiii, 353, 1916).

In 5 cases of mumps a Gram positive diplococcus was isolated from the spinal fluid, the blood, and a lymph gland by the writer. The injection of the organism into the testicle of a rabbit produced severe orchitis in 10 days. These findings confirm the earlier reports of similar organisms from cases of mumps, and it appears probable that mumps is caused by a Gram positive diplococcus and not by a filterable virus. R. L. Haden (*Amer. Jour. Med. Sci.*, November, 1919).

Incubation.—The period of incubation is exceedingly variable. That most commonly observed probably lies between 16 and 20 days. It has been given by different authorities as follows: Flint, 10 to 18 days; Holt, 17 to 20 days; Ashby and Wright, 14 to 21 days; Smith, 19 to 21 days; Jacobi, 2 to 3 weeks; Dukes, 16 to 20 days; Dauchez, 15 days; Roth, 18 days; Hénoch, 14 days.

Symptoms.—Premonitory symptoms are usually slight or entirely wanting. In rare cases malaise and headache precede the actual onset for a week. There is frequently a period of invasion lasting from twelve to twenty-four hours, marked by feverishness, headache, muscular pains, anorexia, and perhaps vomiting. In very many cases the local symptoms are the first to appear. Pain is usually the first of these. It is stitch-like in character and is located in the parotid gland, but radiates into the ear. It is increased by pressure and by all movements of the jaw. It increases in severity and in many cases becomes very intense. In other cases spontaneous pain is not felt, it being developed only upon pressure or movements of the jaw. Rilliet describes three painful points: one at the level of the temporomaxillary ar-

ticulation; one below the mastoid apophysis; the third over the submaxillary gland. Swelling soon ensues, and first appears in the depression between the mastoid process and the ramus of the jaw, forcing the lobe of the ear outward. At first the parotid gland alone is involved and the swelling assumes the characteristic triangular shape, the upper angle being just in front of the ear. As the surrounding tissues become involved, the triangular shape is lost. The cheeks, side of the neck, and regions behind the ear become swelled, the swelling in some instances extending almost to the shoulder. The tumefaction in front of the ear, however, remains as one of the distinctive marks of parotitis. The swelled area is often reddened, but more commonly the skin is normal in color and appearance. Over the gland the swelling is elastic to the touch, but the surrounding tissues are usually edematous and have a doughy feeling and may even pit on pressure.

The pharynx and tonsils are frequently involved by the edema, causing much discomfort. When the disease is unilateral, the head is inclined toward the affected side. When both sides are involved, the head is held rigidly upright, as every movement causes pain. The appearance is characteristic and striking, and in extreme cases the patient becomes almost unrecognizable.

Both sides are usually affected before the attack runs its course. They may be attacked simultaneously, but more frequently the inflammation occurs upon one side a day or two before it appears on the other. Of 228 cases reported by Holt, both sides

were affected in 215. The interval is sometimes a week or more, but more commonly it is not more than three days. In unilateral mumps the left side is affected more frequently than the right.

The swelling commonly reaches its height on the third day; it remains stationary for two or three days, and then subsides with greater or less rapidity. The edema of the surrounding tissues is the first to disappear. After the edema has gone the gland is sometimes slow to gain its normal dimensions. Seven to ten days are required for the disease to run its course, but the duration of the illness depends also upon the interval between the involvement of the two sides. A patient of my own was confined to the house almost a month. The parotid on the right side was attacked a week after that on the left, and this was followed by orchitis on the eighteenth day.

The other salivary glands are not infrequently involved, and in rare cases the submaxillary glands alone are affected.

The secretion of saliva is usually diminished, but occasionally it is increased. This, together with the painful swelling of the face, edema of the throat, and constitutional symptoms, renders the patient extremely wretched. Attempts to examine the throat are often futile, the patient being scarcely able to open the mouth. He will make no attempt at mastication and refuse food, owing to the pain during deglutition. These symptoms are especially prominent when the tonsils are involved. Even speaking is then painful. Although the swallowing of acids commonly causes severe pain, it does not always do so,

and the popular belief that it is an infallible sign of mumps is erroneous.

Constitutional symptoms are usually not severe. The fever is rarely high. The temperature ranges in ordinary cases from 100° to 102° F. (37.8° to 38.9° C.). It frequently does not go above 101° F. (38.3° C.) at any time during the attack, but in severe cases it may reach 104° F. (40° C.) or even more. Other symptoms are those common to all febrile conditions. When the swelling is extreme, pressure upon the vessels of the neck may cause headache and marked cerebral disturbance. Delirium is sometimes due to this cause. The severity of the disease varies greatly in different epidemics. In some the children are but slightly ill; in others they are quite seriously so when the disease is at its height, and are left weak and anemic.

The blood in mumps shows definite changes in the corpuscular content consisting (a) in a slight increase in the total number of leucocytes, and (b) in a lymphocytosis which is both relative and absolute. The lymphocytosis is present on the first day of the disease and persists for at least fourteen days. The occurrence of orchitis does not invariably alter the blood-picture. The blood changes are of distinct diagnostic value in differentiating mumps from other inflammatory swellings of the parotid or submaxillary salivary glands and from cases of lymphadenitis. A lymphocytosis of the cerebrospinal fluid occurs when mumps is complicated by meningitis or by lesions affecting the cranial nerves. It has, however, also been found in cases of mumps which have presented no clear clinical symptoms of any organic lesion of the nervous system. From a consideration of the blood and cerebrospinal fluid, one is justified in assuming that the virus

of mumps excites an inflammatory reaction, the characteristic feature of which is a great aggregation of lymphocytes. A. Feiling (*Lancet*, July 12, 1913).

Diagnosis.—The rapid onset and almost equally rapid subsidence of the glandular enlargement is a most characteristic feature of mumps. This, together with the location of the tumor and its peculiar shape and large size, distinguishes it from acute enlargement of the lymphatic nodes, as well as chronic malignant growths. The location of the tumor is usually sufficient to distinguish it from the cervical swellings of scarlet fever and diphtheria, but examination of the throat should always be made in cases in which there is the slightest doubt.

Etiology.—Although mumps is spread by contagion, susceptibility is probably less than to any of the other contagious diseases. Close contact is usually necessary. The disease is rarely carried from one person to another by a third, but that is known to have occurred. The disease is rare under 4 years and very few cases in infants have ever been reported. It is rare in adult life and still more so in old age. It is most common between the ages of 5 and 14.

The exact period of infection is doubtful. Contagion is possible from the first symptoms or even before the swelling of the glands has appeared. The power of infection seems to continue in some cases for several days after the first symptoms have disappeared. Isolation, to be effective, must be continued for at least a week after the swelling has entirely subsided, or nearly three weeks from the first symptoms.

Epidemics of mumps occur more commonly in the fall and spring than at any other season. They vary greatly in frequency of occurrence and the extent of territory involved, occurring in some localities almost annually and in others only at intervals of many years. The infective power of the disease varies decidedly in different epidemics. Epidemics of measles and mumps are frequently associated.

Recurrence of mumps is uncommon, but is not unknown, as my own personal experience has positively demonstrated.

Pathology.—Opportunity for post-mortem study of parotitis is so rare that its pathology is not yet fully understood. So far as known, pathological changes are confined to the salivary glands. Infection probably takes place through the salivary ducts, the gland-substance being first involved. The periglandular tissue is involved secondarily. In those cases in which pathological examinations have been made, the salivary ducts have been found to be occluded by swelling and inflammation of their walls. The gland itself is hyperemic and edematous. Suppuration is rare and probably does not occur in simple parotitis. Its occasional occurrence is probably due to pyogenic bacteria which have found admission with the specific germs.

Complications and Sequels.—Among young children complications are rare. Suppuration occurs in about 1 per cent. of the cases, according to Holt, and is usually due to some accidental infection by pyogenic germs. Deafness, due not to otitis media, but to disease of the auditory nerve, has been reported in a very

few cases. It is usually unilateral and permanent. Facial paralysis, multiple neuritis, and other nervous disorders also occur in very rare instances, and nephritis is not unknown as a sequel. Meningitis and ocular complications have also been observed. Pancreatitis with epigastric and vomiting and glycosuria are not uncommon complications.

The writer has seen many cases of epigastric pain with vomiting in the last stages of mumps. Out of 20 cases in one school, 10 followed this course, and all showed tenderness to pressure over the pancreas. Fox reports a similar case: On the fifth day of mumps a boy developed fever, epigastric pain, and vomiting, and a deep-seated swelling was felt in the epigastric region. There was no sugar in the urine, and the boy recovered. Cecil Reynolds (Brit. Med. Jour., ii, 352, 1910).

Pancreatitis may be one or the sole manifestation of the acute infection called epidemic parotitis. The pain and protrusion of the stomach region which some writers have explained as acute mumps pancreatitis may have been merely an acute gastritis as a manifestation of the infectious process. L. Cheinisse (Semaine méd., Feb. 21, 1912).

In the pancreatitis of mumps, pain is the most noteworthy symptom; tenderness in the region may persist after other symptoms have disappeared. Constipation, followed by a colliquative diarrhea, is common. Fever, epistaxis, profuse sweating, irregular pulse, and the facies of grippe are also noted. Jaundice may supervene. The diagnosis, in view of the very obvious mumps, is therefore not difficult. The prognosis is favorable. Raymond (Paris méd., Aug. 3, 1912).

A most peculiar but characteristic complication is *orchitis*. It is most common in adolescents and adults

and is extremely rare in children. Among 230 cases of mumps Rilliet and Barthez saw but 10 cases of orchitis, only 1 being under 12 years. Its frequency undoubtedly varies in different epidemics. The disease is a true orchitis, but epididymitis in rare cases occurs either alone or complicating the orchitis. The disease is, as a rule, unilateral, and occurs usually between the eighth and sixteenth day of the mumps. A chill at the onset is not uncommon, and more or less fever is an accompaniment. The acute symptoms increase somewhat slowly during a period of three to six days, when they subside and the swelling rapidly diminishes. So rapid, in fact, is the return to normal conditions that it is clear that the inflammation does not go beyond the stage of serous exudation. In bilateral orchitis one side precedes the other, as a rule, by one or two days. In many cases, as the orchitis develops the parotitis subsides, which has given rise to the theory of metastasis.

The writer has had 7 cases of partial or *complete* (so complete that not a vestige of prostatic tissue could be made out) atrophy of the prostate, in which an antecedent parotiditis seemed to be the sole etiological factor; in some of these cases (5) the atrophy was accompanied by atrophy of the testicles; in 2 the testicles seemed to be unaffected. W. J. Robinson (Letter to the N. Y. Med. Jour., Mar. 6, 1915).

In a series of 115 cases, epididymitis was met by the writer in 20 instances, in 18 of which it was independent of orchitis. It began about the sixth day of the disease and lasted fifteen to twenty days. In half the cases it was accompanied by distinct swelling of the organ, which in the remaining instances was merely ten-

der. Inflammation of the vas deferens was noted in 40 cases, generally independently of epididymitis or orchitis. It began on the second or third day of the disease, and was bilateral in 26 cases. Twenty-three cases showed prostatitis. Enlargement of the lymph-nodes of Scarpa's triangle was met with in 10 cases, and of those of the iliac chain in 6 cases. Swelling of the tonsils took place in 40 cases. Diarrhea was noted for two or three days in 60 cases. In 2 cases appendicitis suddenly developed on the tenth day; recovery in two weeks took place in both instances under rest, dieting, and local application of ice. Ramond and Goubert (*Presse méd.*, Mar. 25, 1915).

In females inflammation of the breast or ovaries occurs in very rare instances. The number of well-authenticated cases of this complication, it must be said, is very small. Involvement of the thyroid gland and of the lymphatic nodes has been observed.

Prognosis.—Mumps is rarely a serious disease. It usually runs an uneventful course, and under 12 years complications are rare. In children of the so-called scrofulous type resolution is sometimes slow and imperfect. Among 24,635 cases occurring in the army during the Civil War there were 39 deaths; a mortality so high as to lead to doubt regarding the accuracy of the statistics.

Epidemic parotitis was never encountered in Greenland until the infection was brought in 1913 by a ship from Denmark, and of the 2425 individuals in the district, about 1500 contracted the disease. In the writer's special district, 191 of the 285 individuals were affected, that is, 66 per cent. of the men and 68 per cent. of the women. No infant under 2 was affected; 18 per cent. of the

male patients developed orchitis and 5.3 per cent. of the women had mastitis; that is, about half of the women who were nursing infants at the time. Bertelsen (*Ugeskrift for Læger*, Dec. 9, 1915).

Treatment.—Cases of ordinary severity require but little medication. A mild **antiseptic mouth-wash** should be given with a view of preventing infection by pyogenic bacteria. The **diet** should be **liquid** and the child should be kept in **bed** if there is fever. Warm **camphorated oil** is the most soothing application that can be used locally.

When there is considerable tension or throbbing, the **ice-bag** sometimes gives more relief than warm applications. In general terms, the treatment is the same as for other febrile conditions.

Buccal antisepsis, according to Martin, diminishes the chances of testicular complications in parotitis. A 4 per cent. **solution of boric acid** (very hot), **thymol**, or **carbolic acid** should be employed as a gargle, and **pilocarpine** subcutaneously in doses of $\frac{1}{4}$ grain (0.01 Gm.) once daily, to diminish the pain and lower the temperature in cases of orchitis.

The following ointment is recommended by Tranchet:—

R **Ichthyol**,
 Iodide of lead, of
 each 45 gr. (3 Gm.).
 Chloride of Ammonium 30 gr. (2 Gm.).
 Lard 1 oz. (31 Gm.).

This ointment is to be applied to the swelled parts three times a day. In some instances vaselin may be used in place of the lard, and sometimes belladonna may be added with advantage.

Where fever and severe pain are present, sodium salicylate is effective. It should be combined with an alkali:—

R *Sodii salicylat.*,
Sodii bicarb.ã gr. v (0.3 Gm.).
Benzosulphimid q. s.
Aquaq. s. ad f3ss (15 c.c.).

Sig.: Every two or four hours.

Stark (Practitioner, Mar., 1911).

The application every morning of pure tincture of **iodine** to the pharynx and buccal mucous membrane, with special attention to the gingival fold and opening of Steno's duct, is recommended as a prophylactic by the writer from experience in military barracks. A tablet of **potassium chlorate** should also be kept constantly in the mouth. Petrilli (Policlinico, June 1, 1913).

The writer tried **convalescent serum** in several cases, using 5 c.c. for both subcutaneous and intravenous injections. Very little reaction, lessening of pain, and earlier subsidence of swelling and of temperature were noted. Gradwohl (U. S. Naval Med. Bull., Oct., 1919).

2. Metastatic or Symptomatic Parotitis.—This is an inflammation of the parotid gland occurring as a result of septic infection through the blood or through the buccal secretions, in the course of various affections, and often ending in ulceration. It may be acute or chronic. It is oftenest met with in typhoid, typhus, and scarlet fevers, cholera, dysentery, plague, pyemia, pneumonia, influenza, puerperal fever, erysipelas, and other infectious disorders. It may result, also, from poisoning by mercury, lead, and the iodides. Inflammation of the testicles is another cause, especially when the process is gonorrheal. Injuries of the alimentary canal and of the testicle or pelvic organs may also give rise to it. Parotitis may follow abdominal operations, especially ovariectomy, hysterectomy, and laparotomy for peritonitis. It has also been observed in cases of neuritis, facial paralysis, and diabetes.

Symptoms.—When acute the gland rapidly swells. The temperature rises to 103° or 104° F. (39.4° or 40° C.). The whole face becomes enlarged, when both glands are involved, and the lids edematous. The pain is sometimes very severe, owing to the tense capsule with which the gland is surrounded. Pus-formation promptly follows in the majority of cases, and the pus may burrow in various directions,—the auditory meatus, the thoracic cellular tissue, the retropharyngeal tissues, the maxillary joints, etc.,—and cause serious lesions if not promptly evacuated by **incision**.

Parotitis was encountered by the writer in 16 of the 760 cases of typhoid fever in his service. Several of the men died. The typhoid was always unusually severe in these parotitis cases. Cahanescu (Wiener klin. Woch., May 27, 1915).

Case of suppurative parotiditis following pneumonia in a boy of 3 years. Five days later the temperature, which had been in the neighborhood of 99.5° F. (37.5° C.), reached 104° F. (40° C.). No signs in the chest were demonstrable, but on the following day a hard, tender swelling appeared in the right parotid region. Three days later a deep incision below the right ear reached an abscess and a small amount of pus was removed. The smear showed pneumococci and a few staphylococci. The temperature fell and the recovery was uneventful. J. P. Parkinson (Brit. Jour. of Children's Dis., May, 1915).

In the chronic form—which may result from mumps, neighboring inflammatory processes, syphilis, the excessive use of mercury, etc.—the gland is also enlarged, but less painful, and may remain so several years.

Pathology.—The process is a suppurative one. The pus may discharge through the cheek or through

the external auditory meatus, and more rarely into the mouth, esophagus, or anterior mediastinum. The abscess may be confined to the parotid gland and its immediate surrounding tissues or it may be so large as to involve the muscles and other soft tissues, and even the periosteum of the bones. The middle ear is not infrequently involved, as well as the central meninges. Thrombosis of the jugular and other veins sometimes leads to septicemia. In rare instances the process terminates in gangrene.

Prognosis.—The result depends largely upon the condition of the patient at the time of the onset of the parotitis. If much reduced by the primary disease, the complication often precipitates a fatal result. If it occurs during convalescence and the patient is not already reduced, a favorable result may be expected. In other words, suppurative parotitis in itself is not usually fatal. Induration and enlargement of the glands is a common result.

Treatment.—By introducing a probe into Stenson's duct at the first appearance of swelling, and making pressure from the outside, a small quantity of pus may sometimes be evacuated and general suppuration prevented. If this fails, **poultices** should be applied to hasten suppuration. An **incision** should be made, with antiseptic precautions, as soon as fluctuation can be detected. The treatment throughout should be that appropriate for any acute abscess.

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SALOL. See SALICYLIC ACID.

SALOPHEN.—Salophen (acetyl-paramido-phenol salicylate) contains 50.9 per cent. salicylic acid. It occurs in fine, white, odorless and tasteless scales; soluble in alcohol, ether, alkalies, and hot water, and nearly insoluble in cold water. It is not official.

Salophen was introduced as a substitute for salicylic acid and salol by P. Guttman (Berl. klin. Woch., No. 52, '91). It is said to be less poisonous than salol or salicylic acid, because the phenol of the latter remedies is replaced by an innocuous compound of phenol.

DOSE AND PHYSIOLOGICAL ACTION.—Salophen, like salol, seems to suffer no action until it reaches the intestines, when the pancreatic juice splits it up into its component parts, salicylic acid and acetyl-paramido-phenol. As the latter appears innocuous, the further action of salophen is that of its contained salicylic acid. It has, however, certain advantages over the latter in that it is unirritating and tasteless and is not depressing. It may be given for considerable periods of time without causing nausea, anorexia, tinnitus, or other unpleasant symptoms. It possesses antiseptic, antipyretic, and analgesic properties, and is given in doses of from 5 to 15 grains (0.3 to 1 Gm.). The maximum single dose is given as 20 grains (1.3 Gm.); not more than 90 grains (6 Gm.) should be given during the twenty-four hours.

THERAPEUTICS.—The therapeutics of this remedy are the same as those of salol and salicylic acid. It is given in the same cases, and in similar doses, and is generally to be preferred to either of them, for the reasons given above. It is well suited, also, for use in diseases of children.

Salophen has a most favorable influence upon **psoriasis**, used in 10 per cent. ointment.

Salophen exerts an incontestable action upon **acute** and **subacute rheumatism**, but its effects are less constant than those of salicylic acid or sodium salicylate. In **chronic** and **blennorrhagic rheumatism** it has not shown itself superior to other drugs.

In chronic articular rheumatism it is no more useful than the above-mentioned drugs. It is an excellent antineuralgic and analgesic in cephalalgia, migraine, odontalgia; facial, trifacial, and intercostal neuralgia; and in the nervous form of influenza. It produces good results in chorea. It acts well in various skin affections which are accompanied with itching: prurigo, urticaria, pruritus of diabetes, eczema, and psoriasis.

SALPINGITIS. See OVARIES AND FALLOPIAN TUBES, DISEASES OF.

SALT. See SODIUM.

SALVARSAN See DIOXYDIAMIDODARSENOBENZOL.

SANDALWOOD AND OIL OF SANDALWOOD.

—Sandalwood (red sanders; *santalum rubrum*, U. S. P.) is the wood of *Pterocarpus santalinus* (nat. ord., Leguminosae). It occurs in the form of raspings, chips, or splinters. It contains a red coloring matter of a resinous character, known as santalic acid, or santalin, which occurs in fine red, odorless, and tasteless needles; soluble in alcohol, ether, in concentrated sulphuric acid, and in alkalis, but insoluble in water. It is used in pharmacy for imparting a red color to alcoholic solutions and tinctures. It is the coloring principle of the compound spirit (or tincture) of lavender. It has no medicinal properties.

Oil of sandalwood (oil of santal; *oleum santali*, U. S. P.) is a volatile oil distilled from the wood of *Santalum album* (nat. ord., Santalaceae), indigenous to India. East Indian sandalwood oil is a rather viscid, yellowish, or pale-straw liquid, having an unpleasant, resinous, harsh taste, and a faint but persistent aromatic odor. The chief constituent is an alcohol known as santalol.

PHYSIOLOGICAL ACTION AND DOSE.—Oil of sandalwood is a stimulant in small doses, and an irritant in large doses, to the various mucous membranes. It checks the secretions of the mucous membranes and causes dryness of the throat and thirst. S. Rosenberg has noticed, after doses of 60 drops a day, irritation of the alimentary canal, burning

in the urethra during micturition, and an eruption of small red prominences upon the entire surface of the body, involving even the conjunctivæ. Large doses may produce considerable lumbar pain.

Its general systemic action is unknown. It is apparently more stimulating than oil of eucalyptus, and rather less than terebene. It is eliminated by the urinary and respiratory mucous membranes; the odor is sometimes perceptible in the perspiration. Unlike copaiba, it causes no cutaneous eruptions, and is less likely to produce gastric or intestinal disturbance. Absorption and elimination are very rapid; it may be detected by its odor in the urine half an hour after its ingestion. It may be given in doses of from 5 to 30 minims (0.3 to 2 c.c.), in capsules or dissolved in alcohol and flavored with cinnamon, in emulsion, or on sugar.

THERAPEUTICS.—Oil of sandalwood is an efficient remedy in **asthma**, **chronic bronchitis**, in the later stage of acute bronchitis, and in the subacute or chronic stage of **gonorrhea**. It is also used as an ingredient of perfumes. It has also been used in **cystitis**, but care should be taken to avoid large doses, and thereby the urethral scalding pain they cause.

SANGUINARIA.—Sanguinaria, or blood-root, is the rhizome of *Sanguinaria canadensis* (fam., Papaveraceae), a native of eastern and central North America. Sanguinaria contains citric and malic acids, red resin, and starch, but its important constituents are its alkaloids, at least five in number, of which sanguinarine and chelerythrine are the most important.

PREPARATIONS AND DOSES.—*Sanguinaria*, U. S. P. (sanguinaria, or blood-root). Dose, 1 to 5 grains (0.06 to 0.30 Gm.).

Tinctura sanguinaria, U. S. P. (tincture of sanguinaria). Dose, 10 to 40 minims (0.60 to 2.60 c.c.).

Sanguinarine (alkaloid). Dose, $\frac{1}{16}$ to $\frac{1}{8}$ grain (0.004 to 0.008 Gm.).

Fluidextractum sanguinariae, N. F. (fluid-extract of sanguinaria). Dose, 1 to 5 minims (0.06 to 0.30 c.c.).

Syrupus sanguinariae, N. F. (syrup of sanguinaria). Dose, 30 minims (2 c.c.), representing 6 grains (0.4 Gm.) of sanguinaria.

Syrupus pini strobi comp., N. F. (compound syrup of white pine). Dose, 2 fluidrams (8 c.c.), representing 5 grains (0.3 Gm.) each of white-pine bark and wild-cherry bark, together with small quantities of aralia, populus, sanguinaria, sassafras, cudbear, glycerin, alcohol, and a little chloroform.

PHYSIOLOGICAL ACTION.—The powder inhaled causes violent sneezing and free secretion of mucus. It is feebly escharotic. The taste is harsh and bitter. In small doses sanguinaria produces a sense of warmth in the stomach and stimulates the secretions. Moderate doses produce nausea and depression of the circulation. In large doses it causes inflammation of the stomach with intense burning, thirst, vomiting, dimness of vision, dilatation of the pupils, vertigo, great prostration and muscular relaxation, cold and clammy skin, and collapse. After a preliminary increase of arterial tension the heart action becomes depressed. The spinal reflexes are reduced and the spinal centers paralyzed. Death is often preceded by convulsions either of spinal origin or from carbonic acid poisoning due to failure of respiration.

TREATMENT OF POISONING.—The stomach and bowels should be washed out with warm water. The diffusible stimulants should be administered. Digitalis, amyl nitrite and strychnine hypodermically are efficient, with morphine and atropine, if necessary, to relieve pain or severe nausea. The patient should be kept warm.

THERAPEUTIC ACTION.—Sanguinaria is chiefly used as a stimulating expectorant in subacute and chronic bronchitis.

SANTONICA AND SANTONIN.—Santonica (Levant or German wormseed) is the unexpanded flower-heads of *Artemisia pauciflora* (fam., Compositæ), a native of Turkestan and the surrounding countries. It contains about 1 per cent. of volatile oil, 1½ to 3 per cent. of santonin and a variable amount of artemisin. Since the isolation of santonin from santonica, the use of the crude drug has been abandoned.

Santonin occurs in faintly acid, shining,

colorless, flattened, rhombic prismatic crystals, odorless, and at first nearly tasteless, but with a bitter after-taste. It is permanent in the air, but turns yellow on exposure to light. It is soluble in alkalies and most volatile oils, in 5300 parts of cold water, 250 parts of boiling water, 34 parts of alcohol, 78 parts of ether, and in 2.5 parts of chloroform, and nearly insoluble in glycerin. Colored santonin is an unreliable remedy.

PREPARATIONS AND DOSES.—*Santoninum*, U. S. P. (santonin). Dose, 1 to 4 grains (0.06 to 0.25 Gm.) for an adult, ¼ to ½ grain (0.015 to 0.03 Gm.) for a child.

Santonica, U. S. P. VIII (santonica). Dose, 10 to 40 grains (0.60 to 2.60 Gm.).

Trochisci santonini, N. F. (troches of santonin, worm lozenges), each containing ½ grain (0.03 Gm.) santonin. Dose, 1 to 4 troches.

Trochisci santonini compositi, N. F., containing santonin and calomel, of each, ½ grain (0.03 Gm.).

Sodium santoninate, official in the U. S. Pharmacopœia of 1880, is a very soluble salt, a fact which forbids its use and that of other santoninates, since the object of using this remedy is to act locally upon the parasites. When given for other purposes than as a vermifuge the dose is 5 to 10 grains (0.30 to 0.65 Gm.).

PHYSIOLOGICAL ACTION.—Santonin is decomposed in the blood, disturbing the nutrition of the cerebral centers, and producing xanthopsia or chromatopsia, a condition where objects appear yellow, red, green, or blue, either by staining the humors of the eye or by its action upon the retina and perceptive centers; the urine is stained a greenish-yellow, or, if alkaline, a reddish-purple color, due to xanthopsin, a derivative of santonin. Elimination is by the kidneys, is slow, taking about two days for the removal of an ordinary dose. There is an increased flow of urine and more frequent micturition.

POISONING BY SANTONIN.—This often occurs by children eating freely of worm lozenges, or from susceptibility to its action. Toxic doses produce alarming symptoms—muscular tremors, vertigo, cold sweats, mydriasis, stupor and epi-

leptiform convulsions. Death occurs from respiratory failure. A case of urticaria occurred after a 3-grain dose to a child, and a general morbilloid eruption and intense punctiform rash on the buccal and faucial mucous membranes after a 5-grain dose taken by an adult.

Treatment of Santonin Poisoning.—The treatment consists of the use of diffusible stimulants, hot baths, demulcent drinks, belladonna and strychnine, with inhalations of ether to control the convulsions.

THERAPEUTIC USES.—The most important use of santonin is that of a vermifuge to expel the roundworm (*Ascaris lumbricoides* or the *Oxyuris vermicularis* (thread- or seat- worm) from the intestines. It has no effect upon the tapeworm. In persistent incontinence of urine santonin has been efficient when all other remedies have failed. It is often useful when the optic nerve is diseased, to restore the activity of vision, and in some cases of color blindness.

As an anthelmintic santonin should be administered on an empty stomach. Whitla and Demme combine santonin with castor oil, but in aggravated cases the latter preferred to give it in a slightly sweetened oleaginous solution, $\frac{1}{2}$ grain (0.03 Gm.) to 1 ounce (30 c.c.) of olive oil. A previous saline purgative (magnesia or rhubarb and magnesia) removes the mucus in which worms breed. The dose of santonin, given at night, should be followed by a saline purgative in the morning, preferably before breakfast.

Santonin has been recommended by Whitehead, of Manchester, in amenorrhea, especially when due to chloranemia. He gives a 10-grain (0.6 Gm.) dose on two successive nights. Cadogan Masterman has found this method useful in severe uterine colic arising from suppression of the menses.

SAPREMIA. See WOUNDS, SEPTIC.

SARCOMA. See CANCER.

SARSAPARILLA.—Sarsaparilla is the dried root of *Smilax medica*, *Smilax ornata*, *Smilax papyracea*, *Smilax officinalis* (fam., Liliacæ), and other varieties of smilax indigenous to central America, Mexico, Brazil, Honduras, and other trop-

ical and subtropical American countries. The roots are without odor and have a mucilaginous, bitter and acrid taste. Sarsaparilla contains about 3 per cent. of saponin-like substance (separable into 3 glucosides), up to 15 per cent. of starch, a little resin, volatile oil, pectin, calcium oxalate, etc. The glucosides are the important constituents, sarsasaponin, parillin, and smilasaponin, the last two being known as smilacin.

PREPARATIONS AND DOSES.—

Sarsaparilla, U. S. P. (sarsaparilla root).

Fluidextractum sarsaparilla, U. S. P. (fluidextract of sarsaparilla). Dose, $\frac{1}{2}$ to 1 dram (2 to 4 c.c.).

Fluidextractum sarsaparilla compositum, U. S. P. (compound fluidextract of sarsaparilla), containing sarsaparilla, 15 parts; licorice, 12 parts; sassafras bark, 10 parts; mezereum, 3 parts; glycerin, 10 parts; and diluted alcohol to make 100 parts. Dose, $\frac{1}{2}$ to 1 dram (2 to 4 c.c.).

Syrupus sarsaparilla compositus, U. S. P. (compound syrup of sarsaparilla), containing fluidextract of sarsaparilla (20 per cent.), fluidextracts of licorice and senna (of each 1.5 per cent.), and oils of anise, gaultheria, and sassafras (of each 0.02 per cent.). Dose, 1 to 4 drams (4 to 16 c.c.).

THERAPEUTIC USES.—Sarsaparilla is probably inert, or nearly so, in the dose usually given, though moderate doses apparently aid digestion and improve the appetite. Its chief value is as a pleasant vehicle for disguising the taste of the iodides and of the mercurial salts. While there is no evidence of a curative action of sarsaparilla by itself in syphilis, a temporary recourse to the remedy has been considered useful, especially in debilitated patients in whom mercury and the iodides have seemingly lost their beneficial action or have been improperly administered. Phillips recommends this remedy in chronic lung affections with much wasting; in chronic rheumatism and cutaneous disorders with venereal taint. Sir Astley Cooper advises its use in the cachexia caused by chronic suppuration, in chronic abscesses, ulcers, and bone disease. Zittmann's decoction (a decoction of sarsaparilla, calomel, cinnabar, alum, senna, licorice, anise-seed and fen-

nel) is much used by the German physicians in **chronic rheumatism, syphilis, and scrofula**. In domestic medicine *sarsaparilla* has been a favorite blood purifier.

SCABIES.—DEFINITION.—An inflammatory contagious disease of the skin, due to the presence of the *Acarus scabiei* and attended by severe pruritus.

SYMPTOMS.—The eruption produced by the *Acarus scabiei* consists of scattered vesicles and papules, which are usually located between the fingers and on the flexor side of the wrists and elbows. The axillæ, mons veneris, abdomen and buttocks, the penis, the mammae, and in children the legs and feet are the points of predilection next in order. The burrows of the parasite resemble scratches, which, upon close examination, may be seen to be headed. The *Acarus* may readily be extracted from its burrow with the tip of a needle for microscopic examination. The eruption is attended by severe itching, which is especially marked at night. The scratching to which the patient subjects the part greatly increases the local irritation. The eruption may become pustular or complicated by other dermatoses (eczema, urticaria, etc.), and present various characteristics due to the accumulation of epidermic *debris*, dead *acari*, etc., or accumulated crusts. The hairs of the limbs affected are often shed, and the nails may become hypertrophied. Schamberg and Strickler found that of forty-seven cases of scabies, over 80 per cent. showed 5 or more per cent. of eosinophiles; the maximum was 19 per cent., and the average 7 per cent. (the normal maximum is 4 per cent.). The incubation period extends from two days to a week. Occasionally the itching is absent—*apruriginous* scabies. During a general illness scabies is apt to disappear or improve; but the disease reappears as soon as convalescence is established.

ETIOLOGY.—The *Acarus scabiei* is about one-quarter millimeter long, and resembles an eight-footed turtle in general outline; the males live under the skin or epidermic scales, the females under the epidermis in the burrows, where they deposit their eggs. *Acarus* does not inhabit

the prickly layer, but the undermost part of the middle layer of the epidermis. The eczema of scabies is not caused by scratching, but by irritating substances given off by the *Acarus*, according to Török.

While the female mite is visible to the naked eye, the male is much smaller. Females are more numerous than males, and when fecundated penetrate into the epiderm, making a burrow in which they deposit their ova, from 6 or 9 up to 30 in number. The mite cannot retreat because of several bristling hairs projecting from her body; she dies in the burrow; the eggs mature in a few days, and the resulting larval forms emerge upon the surface and become sexually active, become impregnated, burrow, deposit ova and die, and thus the cycle continues. The life of the individual mite is from two to three months. The males live on the surface near the burrows. The disease is very contagious, through contact with affected individuals and any wearing apparel or bedclothing that they may have used.

TREATMENT.—Scabies may be rapidly cured by adopting Hardy's method; scrubbing with soap and water, using a brush twenty minutes; the same procedure thirty minutes, but with the part immersed in the soap-water; rubbing of the part with the **Helmerich-Hardy ointment**: **Carbonate of potash**, 25 grains (1.62 Gm.); **sulphur**, 50 grains (3.25 Gm.); **lard**, 5 drams (20 Gm.).—M. This is left on two hours and the parts are bathed as before, but not brushed. Pruritus may usually be relieved by means of a 2 per cent. **menthol ointment**. Petrolatum is sometimes sufficient.

The simple **sulphur ointment** thoroughly, though gently, rubbed in at night before retiring, followed the next morning by a **warm bath**, is often sufficient to cure scabies when persisted in for two or three weeks, but the **underwear** should be very frequently changed and boiled for half an hour or baked in an oven at 120° C. In many cases the ordinary **sulphur ointment** is too strong; it is always best to reduce its strength by mixing it with an equal quantity of **benzoated lard**. Sulphur baths are also valuable, but ointments can be kept in contact

longer with diseased parts, and are therefore more destructive to the parasite.

Julien recommends painting the entire body with balsam of Peru, 3 parts, and glycerin, 1 part, which exercises a toxic action on the *Acarus*. No soap and water should be used before its application. With a brush a thin layer of the balsam is laid on at night, followed by gentle rubbing. A bath is taken on the following morning. The remedy causes no irritation, as a rule.

For scabies in infants and young children, Hartzell recommends equal parts of styrax and olive oil, or 1 or 2 drams (4 to 8 Gm.) of balsam of Peru to 1 ounce (30 Gm.) of vaseline.

Betanaphthol (20 per cent. ointment), styrax, creolin (10 per cent. ointment), petroleum, and Hebra's modification of Wilkinson's ointment (unguentum sulphuris comp., N. F., which contains precipitated chalk, 10; sublimed sulphur, 15; oil of cade, 15; soft soap, 30; lard, 30 parts) have been used with success.

Scabies has been successfully treated with nicotine soap. It is of a dark-brown color, and may be scented with oil of bergamot. It consists of tobacco extract, 5 per cent.; precipitated sulphur, 5 per cent.; and overfatty soap, 90 per cent.

After thorough bathing the body and limbs may be rubbed lightly with washed sulphur, less than $\frac{1}{2}$ teaspoonful for each person; this to be followed by clean underclothes and clean sheets with $\frac{1}{2}$ dram (2 Gm.) of sulphur dusted between them. If this is repeated every second or third day the cure, in ordinary cases, is complete in a week.

For the treatment of secondary pustular complications Knowles, 1918, recommends ammoniated mercury ointment, 20 to 40 grains (1.3 to 2.6 Gm.) to the ounce (30 Gm.). Incipient boils can be cured by daily rubbing for ten minutes with 25 per cent. ichthyol ointment. If they are recurrent, an autogenous vaccine should be used. Septic ulceration or cellulitis may require rest in bed, and should be treated by the local application of ammoniated mercury in zinc oxide ointment.

Another plan is to change the parasite during the treatment (Montgomery). Use a sulphur-balsam Peru ointment for

three days, a betanaphthol ointment for three days, and a creolin ointment for the remaining time.

SCALP. See HEAD AND BRAIN, DISEASES AND INJURIES OF.

SCAMMONY.—Scammony is the gum resin from *Convolvulus scammonia* (fam., Convolvulacæ), derived from the living roots of the plant. Its chief constituent (80 to 95 per cent.) is a glucosidal resin called scammonium.

PREPARATIONS AND DOSES.—

Scammonie radix, U. S. P. (scammony). Dose, 4 to 8 grains (0.25 to 0.5 Gm.).

Resina scammonia, U. S. P. (resin of scammony). Dose, 3 to 5 grains (0.2 to 0.3 Gm.).

Extractum colocynthidis compositum, U. S. P. (compound extract of colocynth, containing 14 per cent. of resin of scammony). Dose, 5 to 10 grains (0.30 to 0.60 Gm.).

Pilule cathartica composita, U. S. P. (compound cathartic pills containing $1\frac{1}{2}$ grains (0.08 Gm.) of compound extract of colocynth in each pill). Dose 2 pills.

Pilule cathartica vegetabiles, N. F. (vegetable cathartic pills containing 1 grain—0.06 Gm.—of compound extract of colocynth in each pill). Dose 2 pills.

It is also an ingredient of pilula colocynthidis comp. (pil. coctiæ), N. F., of pilula colocynthidis et hyoscyami, N. F., and of pilula colocynthidis et podophylli, N. F.

PHYSIOLOGICAL ACTION.—Scammony is a drastic hydragogue and feebly cholagogue purgative. When given alone it causes considerable griping. It is uncertain in action by reason of its frequent adulteration and its insolubility in the gastrointestinal juices if they are acid. Gastritis and enteritis, if present, contraindicate its use. Given in large doses it may cause severe gastroenteritis and fatal purgation. It should not be given alone, but combined with other cathartics and aromatics, to modify its harsh action. Its effects are usually manifested within four hours.

THERAPEUTIC USES.—On account of its tastelessness it is a favorite purgative in children, combined with calomel

and triturated with sugar of milk. It is useful in **cerebral affections** and **dropsies**, in the form of compound extract of colocynth. It is useful to clear the intestines of mucus and as an anthelmintic against both **roundworms** and **tapeworms**. It is a purgative well adapted to cases of **obstinate constipation** and **impaction of feces** and in cases of **mania** and **hypochondriasis**. W.

SCARLET FEVER. —Scarlatina.

DEFINITION.—Scarlet fever is an acute, infectious, contagious, eruptive, disease presenting, in typical cases, the following features: After a period of incubation of from two to four days there is a sudden onset of sore throat, vomiting, and fever; within twenty-four hours a characteristic eruption appears and continues for about six days, when it terminates in desquamation.

While the average period of incubation of scarlet fever (*i.e.*, the period between exposure and the appearance of symptoms) has been stated to be from two to four days, with a maximum of seven, the latest observations show that this period is very variable. The limits of the period of incubation are practically from four to twenty days, with an average of ten to fourteen days. J. W. Schereschewsky (Public Health Reports, Nov. 27, 1914).

SYMPTOMS.—From the attack so mild that diagnosis is difficult to the fiercely malignant form we see every possible degree of severity. Notwithstanding this variability of type, the majority of cases pursue a fairly uniform course, and may, with propriety, be called **ordinary cases**. Other types may be described as **mild**, **severe**, and **malignant**.

Ordinary Type.—The invasion is usually sudden, and is marked by vomiting, fever, sore throat, and rapid

pulse. Occasionally a short period of malaise precedes the onset of definite symptoms. In older children a chill is sometimes the first symptom; in younger children a convulsion. The vomiting is usually repeated several times, and is not accompanied by nausea. When it occurs late in the disease it is a far more unfavorable symptom than at the outset. The intensity of the period of invasion is usually indicative of the severity of the attack, though this is a rule subject to many exceptions.

The temperature is frequently found to be 103° F. (39.4° C.) at the first visit and may reach 104° or 105° F. (40° or 40.5° C.) on the first day. A temperature on the first day above 104½° F. (40.2° C.) indicates a severe attack; below 102° F. (38.9° C.) a mild attack. The highest point is commonly reached at the height of the eruption. It then begins to subside and becomes normal at a varying period, ranging from the ninth to the fifteenth day. The fever is frequently remittent and in mild cases almost intermittent in character. There is no typical temperature range. The febrile stage, even in quite severe cases, may be limited to six or seven days, or it may be prolonged to fourteen or fifteen days without obvious cause.

Any extensive rise or fall from the level maintained during the fastigium, or a rise interrupting the progressive lymphatic resolution indicates an intercurrent or complicating condition and not an essential part of the scarlatina pyrexia. Lysis in scarlatina begins on the fifth or sixth day, so that if a febrile case shows the beginning of lysis on the second day thereafter, we know that the case was four days old on admission. The existence of a complication is re-

vealed by a sudden rise during the lytical stage, the character of the complication being often shown by the temperature curve, and the changes in the pulse and respiration rate. A somewhat septic curve with increase in pulse and respiration suggests bronchopneumonia; a cardiac complication may be suspected from a suspension of the lytical temperature curve with greatly increased pulse rate and a moderate increase in respiration; a meningitis or meningismus attending an otitis media or mastoiditis is frequently indicated through an interruption of the stage of lysis by an increase of fever of septic character coupled with a lower pulse rate than is usual at the height of the fever, although it might also indicate the presence of an acute glomerular nephritis. Nephritis is not as frequent in hospital cases as in private practice for two reasons: The patient is kept strictly in bed until desquamation is almost complete and is kept on a fluid diet until he has well passed the stage of acute symptoms. H. W. Berg (*Med. Record*, May 11, 1912).

In a study of 17 cases of uncomplicated scarlet fever and of 2 cases of scarlet fever with nephritis, the writers found that examination of the urine for albumin is of more value than the functional tests for the detection of the onset of kidney complication. Veeder and Johnston (*Amer. Jour. of Dis. of Children*, Mar., 1920).

A pulse abnormally rapid as compared with the height of the temperature is quite characteristic of scarlet fever. It is often 150 on the first day, and continues rapid throughout the disease.

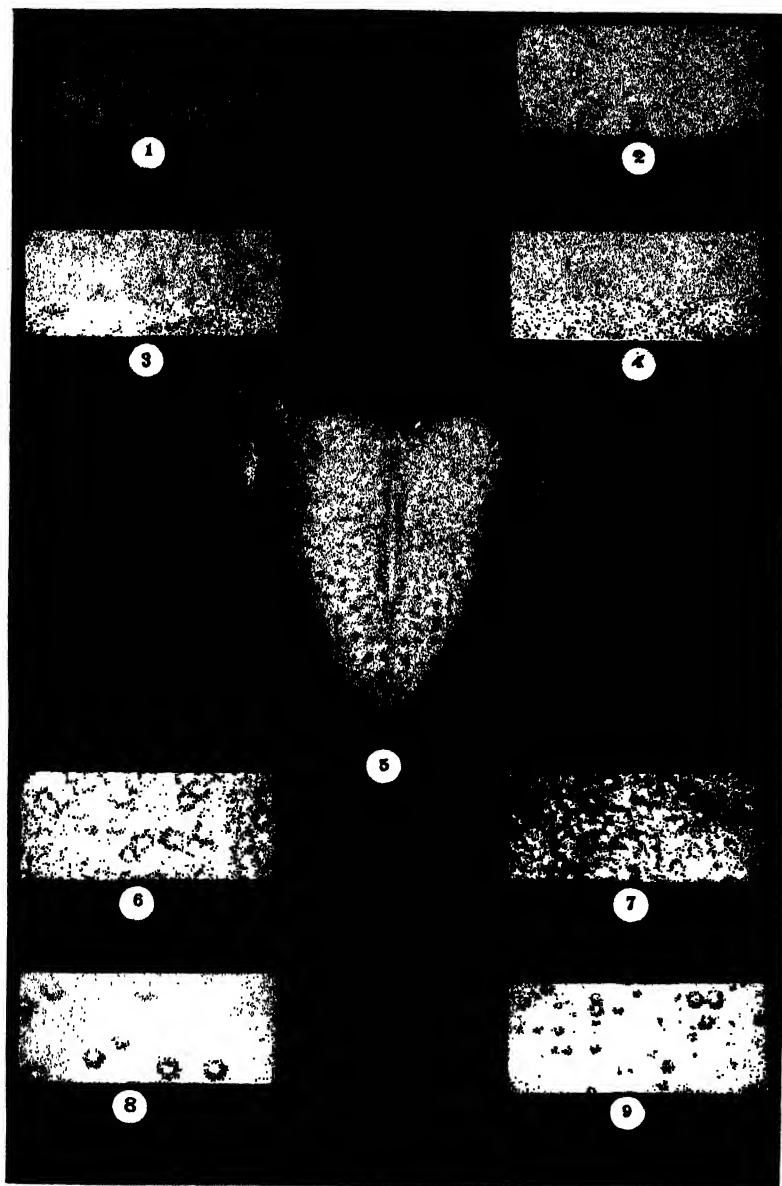
One of the earliest symptoms is sore throat. The fauces, tonsils, and pharynx are of a uniform bright-red color, and on the hard palate numerous dark-red macules may be seen. In mild cases the throat symptoms

may be very slight; in more severe cases the tonsils may be studded with follicular spots, or smeared over with a tenacious exudate closely resembling a pseudomembrane. There is frequently a discharge from the nose, which may consist of clear, tenacious mucus or mucopus. The glands at the angle of the jaw frequently become enlarged. Gregor of Petrograd has recently reported observations upon the thyroid and believes that there is a special form of scarlatinal thyroiditis. It is possible that these changes may have some bearing upon the occurrence of thyroid disease in later life. The spleen is not usually enlarged.

Not one of the individual symptoms can be depended upon to establish the diagnosis. Next to the throat, the condition of the tongue is the most reliable symptom, some enlargement of the papillæ of the tip and border being usually observable, although this symptom is much more frequently missing than is the angina and may occur in other conditions. Miller (*Arch. of Pediatrics*, Apr., 1912).

As the disease progresses, the tongue, which is at first coated, often assumes the so-called strawberry appearance.

Considerable confusion exists as to what the strawberry tongue really is. It is not a white tongue with red papillæ; such a tongue is seen in various conditions. The true strawberry tongue was originally described by Flint as follows: "The tongue in the first days is usually coated. In the progress of the disease the tongue usually exfoliates, leaving the surface clean and reddened and the papillæ enlarged. The appearance is strikingly like that of a ripe strawberry.



Differential Diagnosis of Eruptions in Children's Diseases.

1. Scarlet fever.
2. Scarlet fever: desquamation.
3. Rubella.
4. Rubella.
5. Strawberry tongue of scarlet fever.
6. Variola.
7. Variola: confluence.
8. Varicella.
9. Variola-like varicella.

The strawberry-like tongue is a most persistent where the skin is pathognomonic symptom; it is peculiar to this disease. It is often, but not uniformly, present." The term should be applied to the red, clean tongue with prominent papillæ which follows a coated tongue.

The eruption usually appears within twenty-four hours after the initial vomiting. It is not infrequently seen after twelve hours, and is sometimes delayed for thirty-six hours and in rare cases to the fourth or fifth day. There is frequently intense itching or burning of the skin. The rash is usually well developed during the second day of its appearance. It then continues from four to six days, when it gradually subsides. It usually appears first over the front of the neck and upper part of the chest. It consists of minute points of bright-scarlet color closely grouped together on a slightly reddened skin. They become confluent in places, forming bright-scarlet patches, but over the most of the surface they remain discrete throughout. Being hyperemic in nature, the rash disappears on pressure, leaving, for a perceptible time, a white spot. An eruption of very fine vesicles is seen in rare instances, and occasionally a blotchy eruption appears early on the face, but subsides as the typical rash develops.

One of the most characteristic symptoms of scarlet fever is the desquamation. It rarely begins before the sixth day, and is frequently delayed until the second week. It appears first on the neck and between the fingers. It begins as fine, branny scales, but soon changes to large lamellar scales. Sometimes the skin can be peeled off in strips. It continues from ten to thirty days, and is

most persistent where the skin is thickest. It frequently continues about the fingers and nails after other portions of the body are clear, which explains the readiness with which the disease is conveyed by letters. When the skin has received careful attention, the desquamation is sometimes almost imperceptible. In rare instances a second desquamation occurs.

The urine becomes scanty and high colored during the febrile stage, and frequently contains a slight amount of albumin and sometimes blood and hyaline casts. Except in the more severe forms, suppression is rare and dropsy still more so. These symptoms usually subside as the fever falls. The kidney symptoms at this stage rarely prove serious. They may, however, do so, and always demand attention. The more serious kidney symptoms occur later and will be considered as a complication.

Mild Type.—Scarlet fever is sometimes so mild as to render diagnosis very difficult. The symptoms may be so slight that medical aid is not sought. As a rule, however, there is an onset of vomiting, fever, and sore throat, as in the ordinary type, but none of the symptoms are urgent. The vomiting is not persistent, the temperature does not rise above 102° or 103° F. (38.9° or 39.4° C.), and the throat presents only the symptoms of mild pharyngitis. I have seen an undoubted case in which the temperature never rose to 101° F. (38.4° C.). It may become normal on the fourth or sixth day. The eruption is often very faint, and may not appear on the face. It may, however, be bright and distinctive for twenty-four hours and then fade away so rapidly as to have disappeared by the fifth day. In rare

instances it is an evanescent rash which disappears entirely within twenty-four hours. Nephritis may be a sequel, due in many cases to exposure and lack of care: the natural results of so mild an illness. Owing to this lack of care and isolation, the patient may become very dangerous to others. It is by these mild cases that the disease is sometimes sown broadcast. A mild attack in one child may produce a malignant one in another.

Severe Type.—Not only are the symptoms of this type severe, but the various stages are prolonged. The fever may continue for three weeks or more, and the stage of desquamation for even a longer time. A fatal termination is common, death occurring usually during the second week. The chief peculiarity which distinguishes this from the ordinary type is the presence of septic symptoms due to streptococcic infection. The type might, therefore, with propriety be called *complicated type*. The throat is usually the first to show the evidence of streptococcic invasion. On the third day, and in some cases on the first or second day, a membranous exudate appears on the tonsils and soon invades the pharynx and nasopharynx. A purulent nasal discharge appears, and the lymphatic glands at the angle of the jaw begin to swell, the cellular tissues being so involved as to often cause immense enlargement. The Eustachian tubes are involved, and purulent otitis media follows; but the larynx commonly escapes.

In 10,000 cases recorded in ten years, 21.06 per cent. had ear disease. There are two forms of scarlatinal otitis. The first is a comparatively mild ordinary inflammation, and has

no relation to the scarlet fever except that it occurs at the same time. It is most frequent in cases with little or no throat trouble. The second type is the so-called scarlatino-diphtheritic or necrotic otitis, and is brought about by the same specific cause as the scarlet fever itself. It differs from the first type in being very much more severe and involving extensive necrosis of the soft parts and bones. P. Manasse (Monats. f. Kinderheilk., July, 1913).

The urine contains albumin and perhaps blood-cells and hyaline and epithelial casts. Symptoms of general septic infection rapidly supervene. There is low delirium or stupor; the child refuses nourishment and may die from exhaustion; but sudden death is not uncommon. Others, after overcoming one complication after another, slowly recover after a tedious convalescence.

Malignant Type.—Though very rare, malignant scarlet fever does sometimes occur. It begins with convulsions and hyperpyrexia. The scarlatinal poisoning may be so intense as to cause death within twenty-four hours. More commonly, death does not occur before the third or fourth day, the patient being comatose or delirious. The nervous symptoms are so marked that some writers have given to this type the name of *cerebral scarlet fever*. In a case of my own the initial symptoms were convulsions, hyperpyrexia, and hematuria.

The writer encountered 16 cases of scarlet fever with the clinical manifestations of meningitis among 400 scarlet-fever patients in the course of nine months. When the fluid escaped under high pressure on lumbar puncture, great relief followed, but when the pressure was not high, the lumbar puncture did not seem to benefit,

but it proved very instructive by permitting the exclusion of a suppurative or serous meningitis. The prognosis did not seem to be affected by the pseudomeningitis, as the severity of the scarlet fever was what determined the outcome. Sachs (Jahrb. f. Kinderheilk., Bd. lxxxiii, Suppl., 1911).

Surgical Scarlet Fever.—Patients who have undergone surgical operations are unquestionably very susceptible to scarlet fever. Such scarlet fever, however, is not essentially different from the usual disease. It is simply scarlet fever in a surgical case. It is, no doubt, true, as Osler has shown, that the eruption which has frequently led to a diagnosis of scarlet fever is nothing more than the red rash of septicemia. It is a fact that surgical scarlet fever is much less common since surgical septicemia has become less frequent.

In 12 out of 28 cases of scarlet fever developed among hospital patients, the infection followed an extensive operation and in 1 a severe burn. The incubation was only three days in 10 and from five to eight days in the others. The infection doubtless occurred in the operating room. Kredel (Arch. f. klin. Chir., Bd. lxxxvii, nu. 4, 1908).

DIAGNOSIS AND ETIOLOGY.

—Age is first among the predisposing causes. The disease is rare under one year, but I have seen an undoubted attack of scarlet fever in an infant of one week. Up to 5 years the susceptibility steadily increases and reaches its maximum; after 8 years it rapidly decreases, and is slight during adult life. Sex does not influence its occurrence.

A patient of the writer developed typical scarlet fever while nursing her month-old babe. The disease ran the usual course without complica-

tions and the infant continued to nurse and thrive without contracting the disease. Scarlet fever is rare in infants less than a year old, and it is possible, he thinks, that the mother's milk confers a passive immunity on the child. Delmas (Arch. des méd. des enfants, Feb., 1911).

Scarlet fever is rare in breast babies, particularly during the first six months. It is more common in boys. The complications during the first half-year are more frequent and more severe, the most serious being gangrenous sore throat, and the most frequent lymphadenitis. L. V. Ak-senoff (Roussky Vrach, Sept. 29, 1912).

Of 3603 cases of scarlet fever analyzed by Pospischill and Weiss there were only 28 cases during the first year, and these had their incidence during the later months of the year. The author had the opportunity of observing 9 cases of scarlet fever in infants less than 3 months of age and 1 case in an infant 9 months old. With the exception of the last, all were the infants of mothers suffering from scarlet fever.

The clinical phenomena in all of these cases were somewhat as follows: From three to seven days following the onset of the disease in the mother the infant took sick with a moderate fever lasting from two to four days. There was the characteristic tongue with the reddening of the tonsils and of the soft palate. In no instance was there any membrane on or necrosis of the tonsils. There was at first some difficulty in nursing and a disinclination to take the breast. Carl Levi (Beitrage z. Klinik d. Infektionsk. u. z. Immunit., Bd. ii, nu. 2, 1914).

That scarlet fever is an infectious disease does not admit of doubt, but the specific germ has not yet been discovered. Three theories have been advanced as to its etiology, namely, that it is due to (1) streptococci; (2)

protozoa; (3) a filterable or ultra-microscopic virus. That it is caused by a protozoön is possible, but the theory has by no means been confirmed. The filterable theory cannot be excluded, but is largely theoretical.

The serum of scarlet-fever patients contains specific antibodies for an unknown virus. This unknown virus seems to be present especially in the cervical lymph-nodes. K. K. Koessler and J. M. Koessler (Jour. of Infectious Dis., Nov., 1911).

It has been fully demonstrated that streptococci play an important rôle in the causation of many of the symptoms. It has been urged by some that streptococci are the cause of the disease itself, but this ground is untenable. They are, however, the cause of the pseudomembranous exudations of the throat, and undoubtedly cause the otitis and adenitis, and probably the nephritis, pneumonia, and joint lesions. The streptococci thus far found cannot be differentiated from other streptococci. The evidence fails to support the belief that the streptococcus of scarlet fever differs from that of other infectious processes.

The writer examined the blood of 523 children suffering from scarlatina for streptococci, and concludes that the organism is found only in 2.1 per cent. of all cases. V. N. Klimenko (Arch. des Sci. Biol., St. Petersburg, No. 3, 1912).

The cause of scarlet fever has never been definitely determined and the attempts to transmit it to monkeys have met with only very limited success. The writer believes that it is a streptococcic infection, though this assumption has not been proved or disproved with certainty. Many clinical facts seem to prove that a special susceptibility on the part of the patient is an important factor in the development of scarlet fever, and that it may be regarded as an anaphy-

lactic reaction to a streptococcic infection. Kretschmer (Jahrb. f. Kinderheilk., Sept., 1913).

Whatever the cause of the primary disease may be proved to be, it is certain that streptococci are the direct cause of the secondary symptoms. They are so constant in their presence, and so active in the production of the more serious symptoms and complications, that they must be regarded as important factors in the production of the clinical picture which we know as scarlet fever. The disease as it commonly appears is a mixed infection, the more malignant and fatal symptoms being due not so much to the primary as the secondary infection.

Staphylococci and diphtheria bacilli are sometimes found in conjunction with streptococci.

The inclusion bodies studied by Döhle, of Kiel, have been farther studied by Nicoll and Williams, of New York. These are small bodies found in the protoplasm of the polymorphonuclear leucocytes. While some observers regard them of importance in the diagnosis of scarlet fever, it cannot be said that their true significance has as yet been determined. They are rarely found after the sixth day of the disease.

Other diagnostic signs have in recent years been proposed, the value of which, as is the case with Döhle's sign described above, has not as yet been determined.

Döhle's leucocytic inclosures are found in many other conditions. Their absence, however, is of diagnostic significance, because they are found in the early stages of all scarlet fevers; a negative result therefore excludes scarlet fever, and the early diagnosis of the disease may be made by their presence. A. Belák (Deut. med. Woch., Dec. 26, 1912).

The writer has examined a number of scarlet-fever patients for the cell inclusions, 14 with pneumonia and a number of patients with other affections, including 11 with anemia and 5 with measles. The inclusions were found constantly in every case of recent febrile scarlet fever, less numerous in the milder cases and declining as the disease progressed. After the seventh day scarcely any were to be found. They are no aid in diagnosis, therefore, after the first few days, and they are not pathognomonic for scarlet fever, as they occur with the same constancy and as abundantly in croupous pneumonia in children. Schwenke (Münch. med. Woch., Apr. 8, 1913).

Leede's sign (Münch. med. Woch., Feb. 7, 1911) is obtained in the following way: Apply a rubber band to the arm sufficiently tight to render the veins very conspicuous and the forearms and hands cyanotic, without obliterating pulse. After ten or fifteen minutes remove the band. Put the skin of flexor surface of elbow on stretch, to render it anemic. Hemorrhagic extravasations on this surface, appearing as very fine, dark points, favor a diagnosis of scarlatina, while their absence speaks strongly against the presence of this affection.

The writer confirms the findings of Rumpel and Leede in regard to petechial hemorrhages from artificial stasis in scarlet fever. He has noticed this phenomenon frequently in making blood examinations in scarlet fever, and found it positive in 26 out of a series of 32 cases. In doubtful cases in children, where the throat signs were suspicious, a positive result was always confirmed by the development of typical scarlet fever. Bennecke (Münch. med. Woch., Bd. lviii, S. 740, 1911).

Study of 100 patients with various affections to determine the diagnostic value of the Leede sign. It was not positive in healthy controls, but was found positive in heart disease, bronchitis, pneumonia, acute hepatitis and nephritis, cerebral hemorrhage, ty-

phoid and puerperal fevers, and tabes. These findings deprive the sign of any specific diagnostic value. It seems to be a manifestation of diminished resistance in the walls of the smaller blood-vessels. U. Morandi (Gazz. degli Ospedali, Apr. 2, 1912).

The tourniquet or Rumpel-Leede sign occurs regularly in scarlet fever, but is found also in measles, and in some cases of diphtheria, syphilis and tonsillitis. It permitted an early diagnosis of scarlet fever in a number of the writer's cases, before the eruption developed. Meyer (Deut. med. Woch., Oct. 24, 1912).

Pastia's sign (La Tribune médicale, No. 46, p. 726, 1910) consists in a deep-rose-colored, linear exanthem in the skin-folds of the anterior aspect of the elbow. The lines are usually two to four in number. They can be caused to stand out in contrast by exerting gentle pressure on skin, then quickly removing it. It was uniformly present in 73 cases, appearing with the rash and usually lasting two or three weeks longer than the rash. It occurs in other diseases, but only in such as can easily be differentiated from scarlatina.

The **Wassermann reaction**, according to Ruhens (Berl. klin. Woch., Oct. 19, 1908), will, under certain conditions that have remained undetermined, prove positive in scarlet fever as it does in syphilis.

Case of scarlet fever in a girl, 16 years old, in which Wassermann's test for syphilis produced a positive reaction. Four weeks after the commencement of the illness the test became negative, and remained so. Holzmann (Münch. med. Woch., Apr. 6, 1909).

The writer examined 55 scarlet-fever patients and obtained a positive Wassermann reaction in 18. This positive reaction occurs after the subsidence of the acute symptoms and generally only in the severer cases. It usually disappears by the end of the period of desquamation and has no effect on the diagnostic importance of the reaction in syphilis. Jakobovics (Jahrb. f. Kinderheilk., Feb., 1914).

The **diazo-reaction** seems to afford aid in identifying scarlet fever from measles.

The diazo-reaction was found positive by the writers in 17.3 per cent. of scarlet fever, but also 12.9 per cent. of diphtheria patients during the first week of these infections. It is during this week that scarlatiniform serum rashes are so apt to develop and make a differential diagnosis from scarlet fever quite difficult. The percentage of positive reactions in serum sickness was much lower. The value of the diazo-reaction in differential diagnosis is very slight. Yet the reaction being positive in 75 per cent. of cases of measles, a negative reaction in a case presenting a morbilliform rash is of value in the differential diagnosis from measles. Woody and Kolmer (*Arch. of Pediat.*, Jan., 1912).

Copper sulphate may produce a fleeting exanthem and other signs suggesting scarlet fever.

Copper sulphate is used for spraying grape-vines in France, and 2 children who had been eating grapes thus sprayed developed symptoms deceptively simulating scarlet fever. The diagnosis of scarlet fever was made without hesitation, but it had to be revised, as the children were quite normal again by the fifth day. Vomiting, sore throat, headache and a lively rash over the entire body were the main symptoms. Lasalle (*Arch. de méd. des enfants*, Feb., 1916).

Leucocytosis is found in virtually all cases, the maximum being reached during the first week in uncomplicated cases. It then gradually subsides.

Comparing the findings in 10 cases of scarlet fever with those in 7 of typhoid, pneumonia, gonorrhea or gastroenteritis, the writer concludes that a typical polynucleosis accompanies the onset of the eruption in scarlet fever. It is pronounced and remains high during the first two or three days of the eruption, even in

very young children. The number of mononuclears declines, especially the proportion of lymphocytes. The eosinophiles fluctuate, but are generally increased, especially by the end of a few days of the disease. Pater (*Arch. de méd. des enfants*, Aug. 1909).

Transmission.—Grave doubts have been expressed in recent years regarding the ability of the desquamation scales to transmit the disease. No positive statements can be made until the actual cause of the disease has been demonstrated. I can only express the personal opinion that evidence against the belief in the transmission of the disease by desquamation scales and clothing has not been fully established.

Scarlet fever is not communicable in the early stages, but is transmitted mainly by the secretions from the mouth, nose and ears. The exfoliated epithelium, after the fourth or fifth week, does not seem able to carry contagion. Zangger (*Correspondenzblatt. f. Schweizer Aerzte*, Mar. 1, 1909).

Many cases of scarlet fever are so atypical as to go unrecognized until a sequela makes its appearance. It is a disease of direct infection; it is rarely carried by a second person or object. The most contagious period is early in the disease during the period of angina, rash and temperature; therefore, the danger of transmitting the disease during the desquamation period is much exaggerated. Kerley (*Amer. Jour. of Dis. of Children*, Jan., 1911).

So long as nasal and aural discharges exist, just so long will cases of scarlet fever be infective. Sexton (*Arch. of Diag.*, May, 1915).

Experiments seem to show that the specific germ of scarlet fever exists in the blood, for inoculation with the serum into susceptible animals produces a typical attack of the disease.

It is also found in the various secretions, as shown by their power to generate the disease.

The micro-organism, while more tenacious of life than is that of most other diseases, either lacks the power of gaining a foothold, when implanted in the system, or is less readily conveyed through the air. It is at least a fact that many more children escape scarlet fever than measles, and its spread is more readily controlled.

The chief source of infection is the patient himself, but the area of contagion is limited to a few feet. The desquamation scales have long been regarded as extremely infectious. Their retention by clothing, bedding, and the walls of the rooms is one of the most common causes of infection. The purulent secretions from the throat, nose, and ear are also very infectious, and are probably the chief sources of infection.

Scarlet fever is spread by indirect infection more frequently than any other disease except diphtheria. Its specific micro-organism is more tenacious of life than that of any other disease, except, perhaps, smallpox. Authentic cases have been reported in which it maintained its vitality for a year or more. It may be conveyed from one child to another in the fur of cats and dogs, and it is probable that these animals may suffer from the disease. The contagion clings to rooms with great tenacity, being usually lodged in the wall-paper or in cracks of the walls, ceilings, and floors. The conveyance of scarlet fever by milk and other articles of food is undoubted.

The celebrated epidemics of Hendon and Wimbledon were believed by Dr. Klein to be due to scarlet fever

in the cows, but this belief has not been substantiated. It is probable that the disease from which those cows suffered was not true scarlet fever.

An epidemic of scarlet fever that occurred in the city of Evanston, near Chicago, in the winter of 1906-7 showed conclusively a connection between the extension of the disease and the use of milk from a certain source of supply. This source had been under suspicion on account of a number of cases of scarlatina occurring during the previous summer and fall, but the real epidemic began early in January, 1907, and was at its height between the 14th and 19th of the month. Whole families were attacked in a day, and a notable proportion of the patients were adults. H. B. Hemenway (*Jour. Amer. Med. Assoc.*, Apr. 4, 1908).

The disease has been conveyed by letters written by hands in the stage of desquamation. An attendant upon a case of scarlet fever may carry the infection to other children by the clothes, hands, or beard.

The portal of entrance in most cases is undoubtedly the nasopharynx. It is here that the first local symptoms appear, and all the evidence points to the fact that both the primary and secondary micro-organisms commonly enter the system at this point.

In cities scarlet fever is endemic, a few cases appearing in the health reports every week, but at intervals it becomes epidemic, usually during the fall and winter. Epidemics of scarlet fever usually spread very slowly as compared with those of measles.

Period of Incubation.--The period of incubation is shorter than that of any other infectious disease, except, perhaps, grippe and diphtheria. The extremes range from a few hours to fifteen days. In 87 per cent. of cases

Holt found the period to be less than six days and in 66 per cent. between two and three days.

Period of Infection.—The period of infection is long. The disease is not infectious during the period of incubation, but it may be so from the first appearance of changes in the throat. The most actively contagious period is at the height of the febrile stage: on the third, fourth, and fifth days. The infectious power then diminishes, but increases again during the stage of desquamation. The period of contagion continues until the last evidences of desquamation have disappeared. The purulent discharges from the throat, nose, and ears are capable of infecting others, and isolation should not be relaxed until they have disappeared. The conventional forty days is not, in most cases, too long. It should be as much longer as the condition of the skin and mucous membranes may indicate.

Report of 45 personal cases in which children discharged from the hospital as fully cured of scarlet fever, the forty-second day, infected other members in the home to which they returned. In 6 cases the children gave the infection in four days to other children after their return; in some others the interval was from five to twenty-five days, but in the majority it averaged seven. It is still a question how long a child with scarlet fever should be isolated. The present six weeks' rule is inadequate. The best plan would be to have special convalescent homes for children with scarlet fever and diphtheria. Baginsky (*Deut. med. Woch.*, Apr. 18, 1912).

PATHOLOGY.—In uncomplicated scarlet fever the lesions are confined to the skin and throat. The lesions of the skin are those of acute dermatitis. The papillæ and the stratum beneath

become infiltrated with fluid, while about the blood-vessels there are aggregations of leucocytes. The production of epithelium is greatly increased during the acute stages, which result later in profuse exfoliation of the superficial layers. In the later stages in addition to this, according to Neumann, there is also a profuse development of exudative cells, particularly among the ducts and follicles. These cells easily reach the epithelial surface: a fact which accounts for the great infectiousness of the desquamating cells.

The throat changes in uncomplicated scarlet fever are catarrhal in nature, and are an essential part of the disease. The croupous and diphtheritic membranes must be considered as complications. The pathological changes in the tongue are similar to those in the skin.

Complications and Sequelæ.—ANGINA.—Except in a very few mild cases, the throat always shows some pathological change. A catarrhal condition of the throat is normal to scarlet fever, but membranous exudates and gangrene are not essential to it.

The true nature of the membranous inflammation seen in scarlet fever was long a subject of discussion, which has been settled by the bacteriologist. With few exceptions, the angina of the early stages is pseudodiphtheria, that of the late stages true diphtheria. While primary pseudodiphtheria is a mild disease, the death rate being rarely over 5 per cent., secondary pseudodiphtheria is very dangerous and fatal. The membrane may appear on the throat on the first or second day, but it is not usually seen before the third day. It is generally

confined to the tonsils; but frequently fills the throat and nasopharynx. It shows a tendency to invade the ears and nose and to shun the larynx. It reaches its height about the sixth or seventh day. It frequently presents all the local characteristics of diphtheria together with the general symptoms of septicemia. The exciting cause of this membranous inflammation is the *Streptococcus pyogenes*. It is occasionally associated with the *Staphylococcus aureus* or *albus*, but the streptococcus is the more commonly observed. It occurs not only in the pseudomembrane and the tissues underneath it, but is found in the blood in large numbers. Through the agency of the toxins which it generates it is unquestionably the cause of the complications and general septicemia. The pseudomembranes which appear late in the disease are usually associated with the Klebs-Löffler bacillus. Diphtheria is, in the fullest sense of the word, a complication, and is not an essential symptom of scarlet fever.

OTITIS, next to angina, is the most common complication, and in its results is one of the most serious, as it is a common cause of deaf-mutism. It results from extension of the inflammation from the throat through the Eustachian tubes. The tendency to ear involvement varies in different epidemics, but it is more common in young patients. It does not usually occur until the second week, and, as a rule, involves both ears. Its presence may be indicated by earache and an increase in the fever, but frequently a discharge is the first indication that the ears are involved. The process is prone to be a destructive one and to result in long-continued

suppuration. It sometimes leads to a rapidly fatal meningitis.

ADENITIS and CELLULITIS are common results of streptococcic invasion of the throat. Not only are the lymphatic glands themselves enlarged, but there is more or less inflammatory edema of the surrounding tissues. That this is due to secondary infection is shown by the fact that streptococci are found in abundance in both the nodes and edematous tissues around them. Enlargement of the nodes may be detected during the first week, but serious cellulitis does not, as a rule, occur until later in the disease. Suppuration, sloughing, or even gangrene may occur.

JOINT LESIONS.—Although acute articular rheumatism sometimes occurs, the joint affection often called *scarlatinal rheumatism* is, in most instances, a synovitis. It is mild, and is frequently confined to the wrist. It appears early in the second week, continues for three or four days, and disappears, suppuration being rare. It is seldom seen under 4 years. Pyemic arthritis occurs in extremely rare instances, and affects the larger joints, the lesions being multiple. Marsden has recently offered the following excellent classification of the scarlatinal joint lesion: (a) synovitis, (b) acute or chronic pyemia, (c) acute or subacute rheumatism, and (d) scrofulous disease of the joints.

Nephritis.—Albumin may be found in the urine during the acute stage; but it is febrile albuminuria, due to degenerative nephritis, which subsides as the temperature falls. In the grave type kidney lesions may occur, to which the term *septic nephritis* has been given. The urine contains albumin, but blood and casts are not

necessarily present, neither do the rational symptoms of uremia appear.

The most characteristic and common kidney lesion is *postscarlatinal nephritis*, and is a diffuse nephritis. It develops during the third or fourth week, and may follow a severe or mild attack. There may be no interval of apyrexia between the kidney attack and the onset of the nephritis. It may be so mild as to almost escape notice, or it may be so severe as to cause speedy death. Recovery may be complete or incomplete. The first symptom to be noticed is usually edema of the face, which is frequently accompanied by feverishness and restlessness. Dropsy and all the characteristic symptoms of acute nephritis rapidly develop. The urine usually shows a small amount of albumin for a few days before the advent of definite symptoms. As the disease develops, the urine becomes scanty and high colored, and may be completely suppressed. It contains a large amount of albumin, and is loaded with blood-cells and casts. The first evidence of albumin after the second week should be a warning of danger, and should receive immediate attention.

Pneumonia, although commonly found at the autopsy in patients who have died with septic symptoms, is frequently not recognized before death. *Endocarditis* and *pericarditis*, though uncommon, are sometimes encountered. Murmurs are occasionally heard during the course of the disease, which disappear as the active symptoms subside. Permanent organic lesions sometimes develop in conjunction with the late kidney complications. *Nervous symptoms* are rare. The various *serous membranes* are

occasionally involved. Peculiar attacks of symmetrical, *superficial gangrene* have been reported. The disease may be complicated by any of the other infectious diseases.

Second attacks of scarlet fever are extremely rare. They sometimes occur, but in most supposed cases there has been some error in diagnosis. Relapses are more common than second attacks. They result from autoinfection, and usually occur during the second or third weeks.

The writer has met 180 return cases infected by 145 scarlet-fever patients dismissed from the hospital as completely cured and disinfected. The period of incubation of the return cases was from three to fifteen days in 80 per cent. and from fifteen to twenty-five in the remainder. Of the 4178 cases of scarlet fever declared during the year in question, 2392 were treated in the hospital in his charge. None of the adults gave occasion for the return cases; they occurred with children who were much embraced and petted. *Preisich* (Berl. klin. Woch., June 21, 1909).

PROGNOSIS.—The younger the patient, the greater the mortality. Holt, after the study of a large number of American and European cases, concludes that the general mortality may be assumed to be from 12 to 14 per cent., while under 5 years it is from 20 to 30 per cent. It is much lower in private practice than in hospitals. The majority of fatal cases occurs in children under 7 years.

The prognosis depends upon: 1. Amount of poison that has been absorbed. 2. Whether the child is weak and delicate or strong and robust. 3. The occurrence of complications, especially cardiac, pulmonary, renal, and otitic. Very high temperature indicates a bad prognosis. The younger the child the graver the prog-

nosis. Mortality is estimated at from 20 per cent. to 30 per cent. in children under 5 years of age. Causes of death: 1. Scarlatinal toxemia. 2. Nephritis. 3. Brain abscess from extension. H. Brooker Mills (Therap. Gaz., May, 1921).

Prognosis becomes unfavorable on the appearance of the following symptoms, the gravity being in proportion to their severity: Violent onset, high temperatures, convulsions, extensive pseudomembranous or gangrenous pharyngitis, diphtheria, croup, pneumonia, extensive cellulitis, superficial gangrene, nephritis, and exhaustion with general septic symptoms. The prognosis in uncomplicated cases is good.

Sudden death is not uncommon in this disease, and is usually due to myocardial trouble. Weill and Mouriquand (Presse méd., Aug. 5, 1911).

Morbidity of over 7,000,000 cases collected and studied from communities in America, Europe and elsewhere. The most striking fact about case-fatality of scarlet fever in the past half-century has been its consistent, general and marked reduction. The sexes, as a whole, show about equal susceptibility. During the first five years of life males are more susceptible to the disease, while between 5 and 15 years females are distinctly more susceptible. Case-fatality is higher among males at all ages. Nearly half of the scarlet fever cases was found to occur in the five years between 3 and 8 years of age, distributed nearly equally in each of the five years, and 2 children out of 3 at this age contract the disease, when exposed to it in their homes. Ninety per cent. of cases occur under 15 years of age. Mortality is highest in infancy, being from 12 to 20 per cent.; lowest at about 10 years of age, and thereafter gradually increases with age. About 90 per cent. of deaths occur under 10 years

of age. H. H. Donnelly (Wash. Med. Annals, Nov., 1915).

PROPHYLAXIS.—In view of the gravity of the disease and the effectiveness of preventive measures, prophylaxis assumes unusual importance. The most important of all prophylactic measures is complete isolation of the sick. This applies to nurse as well as to patient. If possible, one person should be selected as an intermediary between the nurse and the family. The doctor should always wear, in the sick-room, a gown of muslin or calico fastened at the neck and waist, and long enough to completely cover his clothes. A stethoscope should be used in making physical examinations of the chest.

The period of isolation should not be less than forty days and as much longer as the presence of desquamation or purulent discharges may demand.

The best prophylactic treatment is the removal of enlarged and diseased adenoids and tonsils.

Scarlet fever having appeared in 2 pupils in a school of over 300, the 2 patients were at once isolated and the throats of all the contacts sprayed with a 1:2000 solution of **mercury perchloride**. No other cases appeared, and the remaining children appeared in perfect health, save for the fact that in 131 cases out of the remaining 299 an elevation of temperature varying between 99° and 101° F. (37.2° and 38.3° C.), and lasting for two or three days, was found. There were absolutely no other symptoms or indications of the children being out of sorts. Thornton (Brit. Med. Jour., Feb. 29, 1908).

In the last 28 years 4251 cases of scarlet fever have been reported at Brunn. Sterilization of the premises and measures to prevent infection of others failed in a large number of

cases. It is evident that the virus is transmitted not only in the period of incubation, but long after recovery, far beyond the routine six weeks. The aim should be to remove the virus from the mouth by mechanical means. Kokall (Wiener klin. Woch., Dec. 29, 1910).

Numerous observers of late, especially in England, have shown that by the cleansing treatment of nose and throat with a mild antiseptic healthy children could be kept in contact with children ill with scarlatina without contracting the disease. The writer has treated 2 families, 6 children in each family, where one member had contracted scarlatina, and by the simple process of **cleaning the nose and throat** three times a day for six weeks he has prevented any further spread of the disease. Schultze (Med. Rec., Dec. 10, 1910).

Discharges from the patient should be disinfected with strong sublimate solutions. The bedding, carpet, and clothing should be disinfected with boiling water or steam. The mattress should be destroyed. The room itself should be thoroughly washed—floor, ceiling, and walls—with a 1:2000 sublimate solution.

One room on the top floor of every house should be arranged for a sick-room: the moldings should be plain, and the floor of hard wood; the walls and ceilings should be painted or covered with washable paper; the bedstead should be of enameled iron. It is a fallacy to suppose that dishes in the sick-room, filled with antiseptic fluids, can limit the spread of the disease, or that there is any efficiency, as a prophylactic, in generating steam impregnated with medicinal agents. The use of such agents is liable to generate a false sense of security and lead to the neglect of more important measures.

[The child should have its own dishes. Everything should be disinfected before it leaves the room—i.e., sheets, pillow-cases, towels, and everything used for the patient—in bichloride of mercury solution 1:500 or phenol solution 1:50; also the urine and feces, which should be collected in a bed-pan containing equal parts **chloride of lime** and strong **vinegar**. So far as possible use materials that can be burnt. Diapers could be made of old sheets, and napkins could be made of paper. Hang a sheet at the door and keep it wet with either of the solutions mentioned, as this will catch the dust from the outside and infected material from the inside of the room. Sprinkle one of these solutions on the floor, or mop once or twice a day. Have a gown and cap hanging at the door and a pair of rubber overshoes for your own use. Take the gown off at the door of the sick-room, and have it disinfected between visits. When you leave the room, go to the bath-room and wash the hands and face in a weak bichloride solution. The mail should also be carefully disinfected before it leaves the house, using dry heat, and all animals kept out of the sick-room during the illness, as they are great carriers of the infection.—H. Brooker Mills.]

Streptococcic vaccines have been tried. The most satisfactory of these so far has been Gabritschewsky's, reference to which has already been made on page 342 in the second volume of the present work.

Gabritschewsky's vaccine for scarlet fever is made from streptococci isolated from the blood in the hearts of children, dead of scarlet fever. It is a condensed bouillon culture of

streptococci killed by heating to 60° C., and the addition of $\frac{1}{2}$ per cent. carbolic acid solution. Each c.c. contains 0.02 to 0.03 of the bacterial mass. The vaccine was first used in Moscow in 1904. Usually 10 drops were injected with an ordinary hypodermic syringe. The injections were made during an epidemic of scarlet fever, 185 persons being thus treated, as a preventive measure. A rise of temperature was observed in all but one. A moderate rise in 64 persons, a faint rise in 54, a marked rise in 66. Local tenderness was seen in 66 patients, redness in the injected area in 173; swelling in 103. In many cases there was a rash resembling true scarlet fever, and in 5 patients there was desquamation. There was a general rash in 43 persons, a local rash in 70; no rash in 72 of the 185 patients; only 2 developed scarlet fever; the remainder remained well, save that they showed these temporary complications after the use of the vaccine. Schamarine (Roussky Vrach, June 30, 1907).

The *streptococcus vaccines*, used as advocated by **Gabritschewsky**, have some influence in controlling epidemics of scarlet fever. Their use, with proper care, is attended by no harmful results. They should be given a wider application in this country to prove or disprove the contentions of the Russian physicians. Smith (Boston Med. & Surg. Jour., Feb. 24, 1910).

After using the **Gabritschewsky vaccine** in 700 cases the writer concluded that it had a decided value from a prophylactic standpoint. In comparing the effects observed he states that but one very light case of scarlet fever has occurred among the nurses who have received vaccine treatment, while in a considerably smaller group, under identical conditions, 5 developed severe cases of scarlet fever. Watters (Jour. Amer. Med. Assoc., lviii, 546, 1912).

During a severe epidemic of scarlet fever in a number of villages the

writer used **Gabritschewsky's bacterins**, making about 3000 inoculations. The results were very satisfactory. It was found, however, that a single inoculation does not confer immunity, and that immunity does not last over six months. Polotebnova (Roussky Vrach, July 14, 1912).

[A physician should not attend an obstetric case while in attendance upon a patient suffering with scarlet fever.—H. Brooker Mills.]

TREATMENT.—Many specifics for scarlet fever have been proposed, tried, and found wanting. Much may be done to avert complications and to render them less serious when they occur, and many lives may be saved by judicious management. Mild cases require little or no medication; they usually receive too much.

The patient should be kept in bed for at least three weeks, and should receive a fluid diet for not less than two weeks. Milk is the best diet for scarlet-fever patients. It may be given peptonized or plain. Later in the disease broths, eggs, or meat-jellies may be given. The stomach should never be overfilled.

[The diet should be liquid and nourishing. If the child is breast-fed, have the **milk** pumped from the breast and fed to the child. If a bottle baby, dilute one-half with water if on straight milk, because whole milk constipates and causes tympanites, or give **half milk** and **half Vichy water**, because alkalies help to neutralize the acidity, which is one of the causes of the nephritis. **Orange juice** is very beneficial. **Lemonade** is good, especially if one adds to every pint (500 c.c.) 1 dram (4 Gm.) of cream of tartar. **Cereals** may be cautiously added, and **water** should be given freely.

Avoid the use of salt and exclude soups and bouillon from the diet.—H. Brooker Mills.]

The initial vomiting usually requires no treatment, but the bowels should be acted upon mildly by small, repeated doses of **calomel**. Later they should be kept acting, if possible, by means of **enemata** rather than by the use of cathartic drugs.

In severe cases **stimulants** are required. In malignant cases they should be pushed to the point of tolerance. **Strychnine** is of great value in septic cases with prostration; it may often be combined to advantage with **digitalis**. **Bathing the surface with warm water** followed by **anointing with plain or carbolic vaselin** or a 5 per cent. **ichthyol ointment** should be begun as soon as the first signs of desquamation appear, and should be continued throughout the course of the disease.

For the itching, which is sometimes intolerable, keeping the child restless and irritable, the writer finds **sponging the body with a warm solution of sodium carbonate** (grain x—Gm. 0.6— to— $\bar{3}$ j—60 c.c.), to which a little mucilage has been added, very useful and soothing. Seymour Taylor (Méd. Bull., Aug., 1907).

Tepid baths (28° to 32° C.—82.4° to 89.6° F.) of 20 minutes' duration and given every evening, or if necessary, morning and evening, will often induce sufficient sedation. The unpleasant sensation of heat in the skin is also allayed by such baths, though still more effectually by rubbings with the following liniment:—

Cold cream.

Neutral glycerin....āā 50 Gm. (12 ℥r.).
M. Ft. linimentum.

The liniment should preferably be used luke-warm. A. F. Plicque (Med. Bull.; N. Y. Med. Jour., July 27, 1912).

The throat symptoms of the first few days may be mitigated by giving **cool water** or bits of **ice**. Later **hot drinks** may be given or irrigation of the back of the throat with a weak **hot saline** or **boric acid solution** may be employed. **Chlorate of potash** should be **avoided**. Its beneficial effects are doubtful. **Nasal syringing** should be **avoided** unless clearly indicated by a purulent nasal discharge or obstruction of the nasopharynx. More harm than good may result from overzealous attempts at local treatment of the throat and nose. The most successful treatment consists in the use, not of active and poisonous antiseptics, but of **mild and cleansing washes**, freely and frequently applied.

[As to the toilet of the nose and throat: Swab, spray, or gargle with alkaline solution, according to the age of the child. If the patient be old enough to gargle, this should be done; if, on the other hand, it be too young for that, but old enough to open its mouth and put out its tongue when told to do so, then swabbing may be employed, while, if it be too young to do this, spraying with an atomizer would be better. **Potassium permanganate**, gr. ss (0.03 Gm.), water $\bar{3}$ j (30 c.c.), is a good solution to use four times a day. Do not use potassium chlorate for the sore throat, because of its well-known irritating effect on the kidneys should any of it be swallowed or absorbed. After using the alkaline solution instil a few drops in each nostril of any oily preparation, such as:—

℞ *Menthol* gr. x (0.65 Gm.).
Phenol cryst. gr. ij (0.13 Gm.).
Ol. eucalypt. f3ss (2.0 c.c.).
Liq. alboleni q. s. f3ij (60 c.c.).

H. Brooker Mills.]

Adenitis can only be controlled by checking the septic process at its fountain-head in the throat. The application of **hot oil** or the **hot-water bag** is soothing to some patients, but the use of **cold** is preferable in most cases. **Poultices** should **not be applied continuously**. Diffuse suppuration requires free **incision**. Otitis requires the treatment demanded by the disease in other conditions. The **joint** affections require but little treatment other than **rest and protection**. Rheumatism should receive its own appropriate treatment. Restlessness and nervous symptoms are sometimes relieved by **cold to the head**, or by the use of small doses of **phenacetin**, not enough being given to materially affect the temperature. Nephritis should receive prompt and very careful attention. Its treatment is that of nephritis due to other causes.

A study of 325 cases, with 23 deaths, in the Alexandra Hospital, Montreal, showed that twenty-one days' **milk diet** and twenty-one days' **bed** should be the rule to prevent death from nephritis. J. McCrae (Montreal Med. Jour, Sept., 1908).

The temperature may require attention from the outset, but it should not be forgotten that a high temperature is normal to scarlet fever. It may be allowed to run, therefore, without interference, to a somewhat higher point than in most other diseases. Hyperpyrexia, or a temperature continuously above 104° F. (40° C.), demands treatment. It is best reduced by means of the **cold bath**; but this, for obvious reasons, is less practical in private than in hospital practice. The **cold pack** or **cold sponging** are more available. An **effective method of applying cold**

adopted at the Willard Parker Hospital is thus described by **Northrup**: "The tendency in all cooling processes is for the feet to become cold. To obviate this the patient is placed upon blankets, but the legs, feet, arms, and hands are wrapped in warm, dry blankets, and hot bottles are inclosed in the wrappings. An ice-bag is applied to the head. The face and trunk are freely sponged in warm water and alcohol, evaporation being hastened by fanning, so long as it cools the patient, clears the cerebrum, gives force and improved rhythm to the heart, and leaves the patient to a quiet sleep."

Great caution should be exercised in the use of antipyretic drugs. No coal-tar antipyretics should be used.

[Treat the temperature hydrotherapeutically—i.e., **sponge baths**, **colonic irrigations**, **ice-bags**, etc. In cases of very high temperature, and especially with diminution of urine, once a day **wrap the child in a blanket and place it in water** at a temperature of 90° to 95°; keep it there for from 10 to 12 minutes; take out of wet blanket and place in **dry blanket**, and give **inunction of cacao butter**. Try to have two rooms, one for day and one for night, preferably with a sunshine exposure. Keep temperature of rooms at 68° to 70° F.—H. Brooker Mills.]

In all cases in which hypodermic injections of large doses of **quinine bihydrochloride** were given the infection was cut short. The fever yielded after the second or third injection, desquamation rapidly supervened, and prompt recovery followed. A. Trambusti (Semaine méd., June 18, 1913).

The writer uses **quinine bihydrochloride**, giving a 30 per cent. solution hypodermically in full doses. A single injection is said to reduce the temperature rapidly and to improve

the subsequent course. Chickline (Gac. Med. Catalan., Jan., 1915).

Serum treatment has been tested very extensively, but I feel constrained to say that up to the present time it has not proved of the value hoped for. It is certain that the stock antistreptococcus serums have not shown themselves to be of striking value. Decided results have been claimed for Escherich and Moser's serum, but it has not been generally adopted. Inasmuch as the more serious symptoms of scarlet fever are all largely due to streptococcic infection, the theory underlying the use of **normal serum** is not irrational. At the present writing, however, no positive statements can be made regarding its efficacy.

[The value of **antistreptococci serum** is doubted and its use is limited. There are several conditions where one would not use the serum: 1. In cases with very high temperature. 2. In very young infants or patients who are greatly exhausted from the effects of the disease. If indicated, use 20 to 40 c.c. every 4 to 6 hours. The prophylactic dose to others is 10 c.c., but a single inoculation does not confer immunity, and immunity, when present, does not last over 6 months.—H. Brooker Mills.]

More promising results have been obtained from **serum of convalescents**.

In a recent malignant epidemic of scarlatina at Stockholm, **convalescent serum** was obtained from the fourth to the seventh week of the disease, and 0.5 per cent. of phenol added. It was then used exclusively in desperate cases, with intense intoxication, bad mental state, pulse 140 to 160, cyanosis, fever 40° to 41° C.—cases in which recovery would average much less than 50 per cent. Of 237 cases sufficiently serious to re-

ceive serum, 195 recovered, while 25 died in the first and 17 in the second week of the disease. Of the 195 cures, 101 were very prompt. In 91 cases of the same type who received no serum the mortality was 70 per cent. Mild cases can supply serum as potent as severe cases. Kling and Widfelt (Hygiea, Jan. 16, 1918).

In treating severe scarlet fever with **convalescent serum**, the blood was drawn from the twentieth to the twenty-eighth day. Serums from several patients were mixed, tested for sterility, and stored in the refrigerator. The serum was injected intramuscularly in the thighs in doses of 25 to 90 c.c. (6½ drams to 3 ounces), 60 c.c. (2 ounces) being the usual dose. Commonly a single dose was given, occasionally 2. No local or general disturbances followed. Nineteen cases were thus treated. Quite constantly a fall of temperature began two to four hours after the injection and continued gradually for twelve to twenty-four hours. In purely toxic cases the temperature fell to nearly normal and tended to remain there. In cases with septic complications it rose again after the fall and ran a "septic" course. Weaver (Jour. of Infect. Dis., Mar., 1918).

Report of favorable results in prophylaxis of scarlet fever by the use of a **serovaccine** obtained from the desquamated scales of scarlet fever patients. Horses treated with it developed antibodies in their serum to an amboceptor power of 2000. Of 40 children immunized and allowed to live and sleep in the same bed with scarlet fever patients, not one contracted the disease. Of 25 children in families where there was a case of the disease, not one contracted it. The immunized children were followed for six months, and the persistent presence of the amboceptors confirmed. Di Cristina and Pastore (Pediatria, Jan., 1919).

According to Ramond and Schultz, **sodium salicylate** possesses to a certain degree specific properties.

Sodium salicylate is indicated in scarlatina. It should be given from the start, but on the fifth day discontinued, and resumed from the fifteenth to the twentieth day, when late complications are due. The dose is about 6 Gm. (90 grains) per day, increased to 8 Gm. (2 drams) or more if required. Nocturnal exacerbations being typical in scarlet fever, the drug should be continued during the night. At the fifteenth day the dosage need not be as large. Under this drug the fever subsides by the third day. The throat lesions are rapidly reduced, but with the recrudescence at the fifteenth day, may reappear in an aggravated form. They are rapidly controlled by the salicylate. The latter may abort late nephritis if given in time, but if the complication has several days' headway, should be given cautiously, lest the kidneys be unable to excrete it. If it can pass the kidneys the dose may then be augmented. On all other manifestations of the disease, the drug acts more or less as a specific. Ramond and Schultz (*Jour. de méd. de Paris*, Sept., 1916).

Salvarsan, and especially neosalvarsan, have been much lauded, but neither has stood the test of experience.

[But little medicine should be given, but the free use of **water** is necessary. The one and only drug that is usually necessary is **potassium citrate** in 2- to 5-grain (0.13 to 2 Gm.) doses, or **liquor potassii citratis**, 15 to 20 minims (0.9 to 1.25 c.c.) three times a day. Sweet spirit of nitre should not be given freely. The skin in scarlet fever is not active, and therefore there is no use for a diaphoretic; as for diuretics, the possibility of damaged kidneys should always be borne in mind. If renal inflammation develops, poultices applied over the kidney region may do good. Make **flaxseed poultice** with 16 parts flaxseed and 1 part mustard, or

4 parts flaxseed and 1 part **digitalis leaves**. Put on every four hours during the day, and keep on hot for half an hour. For stimulation, when needed, **caffeine sodium-benzoate** in $\frac{1}{2}$ -grain (0.03 Gm.) doses hypodermically is among the best. **Digitalis** and **strophanthus**, the latter especially in very young children, may be employed by mouth. Itching is very troublesome during desquamation in scarlet fever; **warm baths** followed by **cacao-butter inunctions** are very helpful.—H. Brooker Mills.]

As emaciation and anemia are frequent results of scarlet fever, active tonic treatment should be instituted during the convalescence, the chief reliance being placed upon **iron**. **Basham's mixture** is especially indicated. The **patient** should be particularly **protected from cold**, for exposure not infrequently seems to precipitate nephritis long after its usual period of occurrence.

When the depression becomes threatening the use of **adrenalin** sometimes proves very beneficial, as shown by Hutinel. The 1:1000 solution may be slowly injected intramuscularly in saline solution, the dose varying with the age, from 5 to 10 minims, repeated every hour or two.

The blood-pressure was found in a series of cases to be subnormal in 25 per cent. Pronounced arterial hypotension, especially if accompanied by other signs of acute suprarenal insufficiency, should be treated by **adrenalin**. J. D. Rolleston (*Brit. Jour. of Children's Dis.*, Oct., 1912).

The writer found **adrenalin** very useful in tiding the patients past the danger point when the adrenals seemed to be suffering acutely from the infectious toxic process. **Camphorated oil**, also proved surprisingly effectual. P. H. Kramer (Neder-

landsch Tijdschrift v. Geneeskunde, Sept. 6, 1913).

In the writer's service there were 34 cases of malignant scarlet fever in a total of 550 cases of this disease; in a previous series of 833 cases there were 37 that terminated fatally. Recovery was the rule in destructive lesions in the throat; the defects in the tissues were filled in time and no operation was required. Hutinel (Arch. de méd. des enfants, Feb. 1915).

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SCHLAMMFIEBER.—This name was applied to a form of acute infectious jaundice which occurred among young subjects who had worked in the districts of Breslau that had been recently flooded. It is not entitled to classification as a disease, since it corresponds in every way with acute infectious jaundice (Weil's disease), treated on page 394 of the sixth volume of the present work.

SCLERODERMA.—DEFINITION.

—A disease characterized by induration of the skin, and at times of the subcutaneous tissues, which sometimes progresses to complete atrophy of these tissues.

VARIETIES.—Three main varieties of scleroderma are recognized: the *diffuse*, which is generalized or limited to certain areas; the *circumscribed*, or morphea, which appears in spots; and *sclerodactyly*, which is limited to the hands.

SYMPTOMS.—In the *diffuse* form, after a series of prodromic symptoms, sensations of chilliness or heat, pruritus, and pain in the muscles and articulations, the tissues becoming thickened, stiff, and hard, and appear edematous. The skin is cold and whitish, contracted, and sometimes painful. The face and the upper part of the body may be the only parts affected, but the entire body becomes involved. The skin is, as it were, glued to the skeleton, the fingers and toes being thin and stiff or hooked. A variable amount of pigmentation is usually present in well-developed cases. Gangrene

is sometimes observed, constituting the mutilating form.

In the *circumscribed* variety, the morphea of Erasmus Wilson, the affected spots are limited in area, the spots being flat or raised, oval or rounded. Their color varies from a light pink to a pale or dark violet, and undergoes changes which ultimately give the lesion a characteristic aspect: a whitish-brown squamous center surrounded by a bluish or lilac pigmented border, or ring. They are seldom painful, though pruritus is sometimes complained of. The spots, of which there are generally but two or three, are usually located upon the neck, the chest, the abdomen, the arms, or the thighs. These spots gradually fade away, but occasionally cicatrices are left to mark the location of the lesions. The prognosis in this form is favorable.

In *sclerodactyly* the third phalanx becomes atrophied and its tissues, including the nail, are partially destroyed by abscess. The flexor tendons are contracted and give the finger the appearance of an angular hook by flexing the first phalanx upon the second. Here also the skin is hard, contracted, adherent to the bones, and lilac in color. The prognosis is necessarily unfavorable, owing to the mutilations caused by the disease.

DIAGNOSIS.—The only condition with which scleroderma can be easily confounded is *leprosy*, but the tubercles of the latter disease, the broad dissemination of the skin lesions, the nasal disorder, the character of the ulcerations, and the disturbances of sensation usually facilitate its recognition.

Osler observes that diffuse scleroderma must sometimes be distinguished from brawny, *solid edema*, met with at times in patients with long-standing renal or cardiac disease, in which there is induration following chronic dropsy. In *scorbutic sclerosis* there may be parchment-like immobility of the skin, due to extensive subcutaneous hemorrhages, involving the muscles.

During the stage of swelling it may resemble *myxedema*. In *Raynaud's disease* the infiltration, pigmentation, and extreme cyanosis are not wholly unlike those of scleroderma. The increase of

pigment may suggest *Addison's disease*, since the bronzing may be extreme.

ETIOLOGY AND PATHOLOGY.—

Scleroderma is an angiotrophoneurosis, most frequently observed among neurotic subjects and often in connection with the rheumatic diathesis. It may appear at any age, but chiefly in early adult life, and is more prevalent among women than men. The neurotic influence, however, does not account for all cases, nerve-changes being wanting in the majority. Exposure to cold and wet, rheumatism, nerve shocks, menstrual disorders, traumatism, etc., are named as causes.

Kaposi notes that the lesions follow, to a degree, vascular distribution. The morbid changes peculiar to scleroderma include an endoperiarteritis, which may be traced to various structures: the muscles, the myocardium, the uterus, the lungs, and the kidneys particularly. The sclerosis would thus seem to be a result of the vascular disturbances, through impaired nutrition of the affected areas.

The chief changes in the skin, according to Schamberg, are an increase and condensation of the connective tissue in the corium and the subcutaneous tissue, an increase in the elastic tissue, and a diminution in the caliber of the blood-vessels. Later atrophy of the subcutaneous tissues occurs.

Reines reported 13 cases which seemed to confirm the connection between scleroderma and tuberculous infection.

Of 5 cases of diffuse scleroderma examined by Whitehouse, 3 gave a strongly positive Wassermann reaction, 1 a faintly positive and 1 a negative reaction.

According to Ravogli, 1917, the underlying factor in the disease is a disturbance of equilibrium of the internal secretions of the adrenals, thyroid, etc., while exposure is often the determining factor. Criado, 1918, obtained improvement in one case by **adrenal** administration, and made the suggestion that **adrenin** be also used locally.

PROGNOSIS.—The prognosis is exceedingly unfavorable as regards cure. The disease usually persists throughout life. Improvement occurs in quite a third of the cases. In adults Lewin and Heller report 16 per cent. of cures, and 31 per cent. in children under 15 years of age.

TREATMENT.—The treatment consists in **nutritious diet**, **good hygienic surroundings**, **iron**, and **codliver oil** in ascending doses (the latter up to 10 table-spoonfuls per day); **sodium salicylate**; externally, **steam baths**, **mud baths**, **mercury (by inunction)**, **galvanism**, and **massage**. The most recent remedy is **thyroid gland**; but, according to Osler, it is not of much value. Brocq recommends **electrolysis**, at first at comparatively short intervals; then, when amelioration is manifest, at much longer intervals. Electrolysis does not act by destructive action, but at a distance, influencing even patches not touched. Philippssohn obtained excellent results by the administration of **salol**, in doses of about 7 to 15 grains (0.45 to 1 Gm.), three or four times daily. S. and W.

SCLEROSIS. See INDEX.

SCOLIOSIS. See SPINE, DISEASES AND INJURIES OF.

SCOPARIUS AND SPARTEINE.—Scoparius, N. F. (spartium, broom, broom-tops, besom), is the dried tops of *Cytisus scoparius* (fam., Leguminosæ), a densely growing shrub indigenous to Europe and adjacent Asia, and sparingly naturalized in sandy soil in North America. Its long, slender, erect, and tough twigs are arranged in large, close fascicles which lie parallel with and close to one another, and have a peculiar odor when bruised, and a disagreeably bitter taste. The quality of the drug deteriorates with keeping, the peculiar odor of the recently dried drug being partially or completely lost.

Broom contains two active principles, sparteine and scoparia.

Sparteine ($C_{15}H_{26}N_2$) is a transparent, oily liquid, colorless when fresh, but turning brown on exposure, having an odor resembling that of aniline, and a very bitter taste. Spar-teine is heavier than water. It is but

slightly soluble in water, but readily dissolves in alcohol, ether, and chloroform, and is insoluble in benzene and benzin. Sparteine contains the cardiac properties of scoparius.

The official sulphate of sparteine is prepared by dissolving 10 parts of recently distilled sparteine in 40 parts of diluted (10 per cent.) sulphuric acid, and allowing the solution to crystallize in a warm place. It should be kept in well-stoppered, amber-colored vials. Sparteine sulphate occurs as colorless, rhomboidal crystals, or as a crystalline powder, odorless, but having a slightly salty and somewhat bitter taste, soluble in 1.1 parts of water, 2.4 parts of alcohol, but insoluble in ether and chloroform. It is hygroscopic, and its aqueous solution has an acid reaction.

Scoparin ($C_{21}H_{22}O_{10}$) is a glucoside, occurring in pale-yellow crystals, without odor or taste, and soluble in alcohol, alkalies, and in hot water. It probably represents most of the diuretic properties of scoparius.

PREPARATIONS AND DOSES.

—The only official preparation is:—

Sparteina sulphas, U. S. P. (sparteine sulphate). Dose, $\frac{1}{8}$ to 2 grains (0.008 to 0.13 Gm.).

Unofficial but serviceable preparations are:—

Scoparius, N. F. (broom-tops). Dose, 15 to 60 grains (1 to 4 Gm.), usually in decoction.

Decoctum scoparii (decoction of broom, made by adding $\frac{1}{2}$ ounce—16 Gm.—to 1 pint—500 c.c.—of water, and boiling down to $\frac{1}{2}$ pint—250 c.c.). Dose, 1 ounce (30 c.c.) to be taken every three hours.

Fluidextractum scoparii, N. F. (fluidextract of broom). Dose, 15 to 30 minims (1 to 2 c.c.).

Infusum scoparii, Br. P. (infusion of broom, made by adding 2 ounces—60 Gm.—of dried and bruised broom-tops to 20 ounces—600 c.c.—of boiling distilled water; infusing in a covered vessel for fifteen minutes and straining). Dose, 1 ounce (30 c.c.) every three hours.

Scoparin (the glucoside). Dose, 8 to 15 grains (0.5 to 1 Gm.).

PHYSIOLOGICAL ACTION. —

Internally broom, in large doses, excites vomiting and purging, and in smaller doses increases the urinary output. Sparteine acts upon the heart as a stimulant or tonic like digitalin, while scoparin exerts its action upon the kidneys. Sparteine has a decided effect upon the nerves and spinal cord, lowering reflex action, paralyzing motor nerves, reducing the electrical excitability of the vagus and, finally, causing death by paralysis of respiration, both as a result of its action upon the center and upon the respiratory muscles.

In its action upon the circulation sparteine, according to most observers, causes a transient rise in arterial pressure, followed by a longer period of diminished vascular tension. Laborde, however, claims that sparteine has no influence on the blood-pressure. Small doses slow the heart for a short period and then accelerate it, the volume of the pulse being simultaneously increased. Large doses cause marked depression of the cardiac muscle, and of the vagus. The heart responds to its action in about twenty to thirty minutes, and the effect continues for from six to eight hours.

No cumulative action has been observed. When taken regularly for several weeks, the effects continue for

several days after discontinuing the remedy.

In its action on the muscles, D. Cerna demonstrated that sparteine causes a brief period of increased muscular irritability, that it augments reflex action by a direct influence upon the spinal cord, this increase being followed by a subsequent depression, that it gives rise to convulsions of a spinal origin and generally tetanic, that it causes a primary increase in the rate and force of the heart's action by a direct influence upon the heart, the increase being soon followed by a decrease, due to direct cardiac action and stimulation of the cardioinhibitory centers; it augments the blood-pressure by an action upon the heart, and also by stimulating the central vasomotor system; the arterial pressure subsequently declines, owing to paralysis of the vasomotor system and a direct depressant action upon the cardiac musculature. It is claimed that sparteine strongly and promptly reduces the size of the heart.

THERAPEUTIC USES.—In renal insufficiency with deficient urinary secretion, due to lowered arterial tension, scoparius yields good results; also in the **edema**, or **dropsy**, **accompanying heart lesions**. It is contraindicated in the acute stage of inflammation of the lungs, heart, or kidneys, but in the subacute or chronic stage it may be used with advantage. In **hydrothorax** and **ascites** occasional doses of compound jalap powder may be combined with it to advantage.

Scoparin has been used as a diuretic in doses of from 8 to 15 grains (0.5 to 1 Gm.) by the mouth, or $\frac{1}{2}$ to 1 grain (0.03 to 0.06 Gm.) dis-

solved in water with a trace of ammonia, or in a mixture of 1 part of glycerin and 3 parts of water, given hypodermically.

Sparteine is pre-eminently a heart tonic and heart regulator, rapid in its action, certain in its effects, and producing a regulation of the heart's pulsations in more ways than one. If the pulse rate is below normal, it will cause acceleration, but if above normal, it will bring it down.

Laborde calls it the "cardiac metronome." In **weak and irregular heart** Germain Sée advises doses of from $\frac{1}{4}$ to $\frac{1}{6}$ grain (0.016 to 0.01 Gm.) every four hours. In **heart-failure**, the result of **mitral disease**, it gives the best results. In **valvular disease, with defective compensation**, small doses are apparently more efficacious than large ones. Shoemaker has found sparteine of service in cases of enfeebled cardiac action from **structural lesions**, and also where the innervation of the heart was markedly disturbed. In **mitral disease** it is particularly valuable, even in the advanced stage, when **dilatation** has begun. In cases of **dyspnea**, **palpitation**, and **cardiac debility**, due to **fatty deposition** around the heart, sparteine is satisfactory. In **dilatation** due to **valvular disease** sparteine may be given hypodermically. In **functional cardiac disease**, the result of excessive bodily or mental labor, anxiety, and in "**tobacco heart**," sparteine will yield gratifying results. In **chronic parenchymatous nephritis** sparteine will aid in the elimination of urea and thus prevent uremia. In **valvular cardiac disease, due to acute articular rheumatism**, **cardiac dilatation with failing compensation**, **chorea associated with endocarditis**, **exophthal-**

mic goiter, etc., Cerna has obtained good results from the use of sparteine. In **morphine addictions** sparteine is useful in supporting the heart and system during the withdrawal of the drug. In **postoperative suppression of urine, postanesthetic nausea, and operative shock**, Pettey places great faith in sparteine, but insists that the dose be at least 2 grains (0.13 Gm.), repeated every two to six hours, when the effect of the remedy is to be assured. **Hysterical excitement** is, in many cases, amenable to sparteine sulphate.

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SCOPOLAMINE (HYOSCINE) AND SCOPOLA.

Scopolamine, or hyoscine ($C_{17}H_{21}NO_4$), is an alkaloid obtained from various plants of the family Solanaceae, including *Atropa belladonna*, *Datura stramonium*, *Hyoscyamus niger*, and *Scopola carnioica*. The last-named plant is an herb growing in the eastern Alps, Carpathian Mountains, and neighboring regions, and contains about 0.6 per cent. of total mydriatic alkaloids, including 0.06 per cent. of scopolamine. *Scopola japonica* is another species of the plant, growing in Japan, and containing the same principles as the European scopola. In these two plants, scopolamine is present in larger amount than in the other members of the solanaceous group, the next being hyoscyamus, which, in its total alkaloidal content of 0.08 to 0.15 per cent., contains 0.02 to 0.0375 per cent. of scopolamine (Kraemer). The histological structure of the scopola rhizome, which is the part of the plant used in medicine, closely resembles that of belladonna root. The name

scopola (or scopolia) is derived from Scopoli, an Italian who was professor of botany in Pavia about the middle of the eighteenth century.

Though discovered, the one in hyoscyamus and the other in scopola, hyoscine and scopolamine are identical chemically. Most of the drug being obtained from scopola rather than hyoscyamus, the term scopolamine is often given preference, and in many European countries it is the only appellation used.

Officially, that is to say, from the standpoint of the United States Pharmacopœia, scopolamine and hyoscine are identical in all respects. A slight distinction is, however, sometimes made between the two substances with respect to their optical properties, scopolamine being taken to refer to a completely levorotatory specimen of the alkaloid, i.e., one which rotates the plane of polarized light as far to the left as this particular chemical compound is capable of doing it, and is composed exclusively of levorotatory molecules, while hyoscine is taken to refer to any specimen ranging between the completely levorotatory and the inactive, the latter being a mixture in equal parts of levorotatory and dextrorotatory molecules. The optically inactive variety of hyoscine is termed atrosine. Levoscopolamine, under the influence of light, is gradually transformed into atrosine, thereby suffering some reduction in its *peripheral* nervous effects, i.e., mydriasis, vagal paralysis, arrest of secretion, etc. For ordinary purposes, however, scopolamine and hyoscine are generally considered equivalent. Various preparations that have, in the past, been termed hyoscine have consisted

merely of a more or less impure scopolamine.

PREPARATIONS AND DOSE.

—*Scopolamine hydrobromidum*, U. S. P. (scopolamine or hyoscine hydrobromide) $[C_{17}H_{21}N_4O.HBr + 3H_2O]$, occurring in colorless rhombic crystals, sometimes of large size, with an acid, slightly bitter taste, and slightly efflorescent. It is soluble in 1.5 parts of water, in 16 parts of alcohol, and in 750 parts of chloroform. It should be kept in amber-colored vials. Dose, $\frac{1}{300}$ to $\frac{1}{60}$ grain (0.0002 to 0.001 Gm.).

The following preparations were formerly official:—

Scopola, U. S. P. VIII (scopola), the dried rhizome of *Scopola carnatica*, required to yield not less than 0.5 per cent. of mydriatic alkaloids. Dose, $\frac{3}{4}$ grain (0.045 Gm.).

Fluidextractum scopola, U. S. P. VIII (fluidextract of scopola), containing 0.5 Gm. of mydriatic alkaloids in each 100 c.c. Dose, 1 minim (0.06 c.c.).

Extractum scopola, U. S. P. VIII (extract of scopola), made by evaporating the fluidextract, and required to contain 2 per cent. of alkaloids. Dose, $\frac{1}{2}$ grain (0.01 Gm.).

Hyoscine hydrobromidum, U. S. P. VIII (hyoscine hydrobromide), chemically identical with scopolamine hydrobromide. Same dose.

INCOMPATIBILITIES.—Hyoscine and scopolamine are incompatible with alkalis, tannic acid, potassium permanganate, iodides, and salts of some of the heavy metals, such as mercury bichloride, silver nitrate, lead acetate, and ferric chloride.

M O D E S O F A D M I N I S T R A T I O N.—Scopola, when used, is administered by mouth. The alkaloids scopolamine and hyoscine are gener-

ally administered hypodermically, though oral use is also feasible, the alkaloids being absorbed with almost equal certainty, though less rapidly, than when injected. Solutions of the alkaloids deteriorate quickly on keeping, but Straub has found that by adding to them 5 to 20 per cent. of mannite—a harmless substance which may be injected into the tissues without fear of causing local irritation—they may be kept for an indefinite period without loss of activity.

PHYSIOLOGICAL ACTION.—

Nervous System.—Scopolamine (hyoscine), like atropine, produces distinct effects on both central and peripheral nervous structures. Its central effects differ in quality, however, from those of atropine, consisting chiefly of a pronounced depression of the psychic and motor centers of the brain, the result being a hypnotic effect, which passes, if the dose be large enough, into narcosis. The electrical excitability of the brain is reduced. The human subject to whom scopolamine (hyoscine) has been administered becomes quiet and sluggish, because of early depression of the motor centers, and soon falls asleep. At times these effects appear, after a short period of latency, with marked suddenness, and their intensity may prove alarming to nearby persons. Occasionally sleep is preceded by a short period of excitement, which may either represent an attenuated manifestation in scopolamine of the delirifacient action of atropine or be due to the presence of the convulsive, highly toxic alkaloid apoatropine as an impurity. (This impurity may be detected by adding a little dilute potassium permanganate solution to the solution of scopolamine, the violet

color changing to a yellow-brown if apoatropine is present.) In excessive amounts scopolamine induces either coma or—probably only if impure—a condition of sleep and unconsciousness interrupted at more or less frequent intervals with a delirious outburst or low, muttering delirium. Scopolamine acts upon the spinal cord as on the brain, a more or less complete depression of the spinal reflexes being, therefore, characteristic, especially after large doses.

The peripheral nervous effects of scopolamine are essentially those of atropine, consisting of depression or paralysis of the terminals of the vagosacral autonomic system and of the secretory nerves. The effects of atropine on the pupils, involuntary muscles in general, and secretions are reproduced, though the dosage of scopolamine for simple hypnotic purposes being, as a rule, less than the customary full dose of atropine, these effects are not as often noticed as with atropine. Although the ability of scopolamine to paralyze the endings of the vagus nerves in the heart, and therefore to accelerate heart action is not questioned, many have clinically noticed slowing of the heart after its administration. This is doubtless either an indirect effect, the result of motor inactivity, or due to admixture of some cardiotoxic impurity.

Circulation.—Ordinarily no cardiac acceleration is induced by scopolamine, the dose used being too small. The alkaloid differs from atropine, in that it has no stimulating effect on the vasomotor center. In large doses, it depresses this center from the start, a corresponding reduction in the blood-pressure taking place.

Respiration.—The effect on the respiratory is the same as that on the vasomotor center. Respiration is depressed by full doses.

Eye.—Scopolamine, instilled in the eye, acts like atropine, but more rapidly and in an amount about four times less. A 0.2 per cent. (1 grain to the ounce) solution will dilate the pupil in ten to thirty minutes, and shortly thereafter induce paralysis of accommodation. These effects are due to paralysis of the oculomotor nerve endings in the constrictor muscle of the iris and the ciliary muscle, respectively. The drug does not increase intraocular tension. Its effects on the eye pass off more rapidly than those of atropine, viz., in three to five days. The pupil regains its normal diameter in about seventy hours, and the power of accommodation is recovered in four days (Oliver). A slight stinging or feeling of astringency in the conjunctiva may be experienced after its instillation.

Secretions.—Scopolamine inhibits, like atropine, those secretions which are under nervous control, paralyzing the endings of the secretory nerves distributed to them. Kamensky witnessed arrest of the salivary, gastric, pancreatic, and sweat secretions by the drug in laboratory animals; the effect on the pancreas took place much later than that on the other secretions.

ABSORPTION AND ELIMINATION.—Scopolamine is readily absorbed from mucous membranes. It is more rapidly destroyed in the system or excreted than atropine, and its effects are of correspondingly shorter duration.

UNTOWARD EFFECTS AND POISONING.—The dose of scopolamine

mine borne without unpleasant resulting symptoms seems to vary considerably in different individuals. Occasionally somnolence and dizziness appear in ophthalmic use of the drug. In persons with an idiosyncrasy therapeutic doses may, in addition, produce effects similar to those of beginning atropine intoxication, viz., dryness of the mouth, flushing of the skin, mydriasis, and difficulty in swallowing. The dose ordinarily toxic lies between $\frac{1}{100}$ and $\frac{1}{30}$ grain (0.0006 and 0.002 Gm.). From doses larger than are required for therapeutic effects there result, in addition to the symptoms already mentioned, ataxia, indistinct speech, unconsciousness, perhaps followed by delirium and hallucinations and an accelerated feeble pulse.

Even therapeutic amounts at times produce alarming effects. Thus, cases of collapse from $\frac{1}{100}$ grain (0.0006 Gm.) have been reported, with pronounced muscular weakness, flushing of the face, a hard, rapid pulse, noisy, rapid breathing, twitching of the hands, and cool perspiration. Collapse has also been recorded from ophthalmic instillation of the drug. M. L. Foster has reported the case of a young man in whom four instillations of 1 drop of a 0.2 per cent. solution of scopolamine hydrobromide had been made in each eye at ten-minute intervals—total amount about $\frac{1}{40}$ grain (0.001 Gm.). Fifteen minutes after the last instillations dizziness appeared, followed by dryness of the throat, nausea and attempts to vomit, flushing of the face, motor weakness, and tachycardia (over 160 a minute), attaining their maximum in about two hours; the patient became cyanotic, actively delirious, and had

what appeared to be toxic convulsions. Rapid recovery thereafter took place under morphine and whisky. S. W. Morton has recorded a case of poisoning by $\frac{1}{75}$ grain (0.0008 Gm.) of hyoscine hydrobromide, with inability to swallow and complete paralysis of the soft palate and upper lip. In an ataxic man Gibbs witnessed poisoning, with delirium and convulsions, from $\frac{1}{50}$ grain (0.0012 Gm.). R. A. Morton, after instillation of 2 drops of 1 per cent. hyoscine hydrobromide into the eyes of an adult, observed muscular relaxation and unconsciousness lasting four hours, followed by delirium lasting two hours, and then sleep lasting one and one-half hours. F. Krauss observed excitement lasting over seven hours in a girl of 15, who had instilled 2 drops of a 2-grain to the ounce solution in each eye before retiring.

Fatal results from scopolamine intoxication have been rare. Bastedo has met with fatal collapse from $\frac{1}{50}$ grain (0.0012 Gm.) in an alcoholic man with pneumonia. On the other hand, he witnessed recovery from $\frac{1}{25}$ grain (0.0024 Gm.) in an alcoholic woman verging on delirium tremens. In each of these cases morphine had preceded the hyoscine. Recoveries from $\frac{1}{8}$ and even $\frac{1}{2}$ grain (0.03 Gm.) of hyoscine in cases subsequently receiving more or less therapeutic attention have been reported.

Treatment of Poisoning.—If the drug has been taken by the mouth, the stomach should be evacuated with **emetics** or the **stomach-tube**. **Tannic acid** or **Lugol's solution** may precede this, if they are immediately at hand and the case is seen early. As physiological antidotes, **pilocarpine**, $\frac{1}{4}$ grain (0.015 Gm.), and **strychnine**,

$\frac{1}{30}$ to $\frac{1}{20}$ grain (0.002 to 0.003 Gm.), or **caffeine sodiobenzoate**, 5 grains (0.3 Gm.), or hot, strong **coffee** should be given. Where delirium replaces the unconsciousness or coma, sedatives such as **chloral hydrate**, 10 grains (0.6 Gm.); **tincture of opium**, 15 minims (1 c.c.), or **morphine**, $\frac{1}{4}$ grain (0.01 Gm.) hypodermically, may be availed of. **Electricity** and other excitants of the skin surface may be used, as in opium poisoning, to combat narcosis. In cases with pronounced circulatory depression, **digitalis**, **epinephrin**, **ether**, **ammonia** preparations, etc., should be freely used. **Artificial respiration**, **external heat**, **skin frictions**, and **oxygen inhalations** are other measures that may prove of value.

THERAPEUTICS as Sedative to the Central Nervous System.—In **insomnia** due to **mental excitement**, a persistent wandering of the mind from one subject of thought to another preventing sleep, and in the insomnia of **neurasthenia**, scopolamine (hyoscine) in small doses, such as $\frac{1}{300}$ grain (0.0002 Gm.), is of value where other milder hypnotics fail or have to be discontinued because of a tendency to habit formation. Though less certain in its effect than chloral hydrate, scopolamine has advantages over the latter in being of small bulk, non-irritating, and well suited for hypodermic use. According to Windscheid, as little as $\frac{1}{650}$ grain (0.0001 Gm.) is capable of causing somnolence. In sleeplessness due to pain, scopolamine is ineffectual when given alone, but if combined with morphine in small amounts proves useful, intensifying the action of the latter.

In the insomnia due to **motor excitation**, scopolamine is particularly

effective. This applies in **delirium tremens**, in which, *e.g.*, Lambert recommends a combination of scopolamine hydrobromide, $\frac{1}{100}$ grain (0.0006 Gm.), with apomorphine hydrochloride, $\frac{1}{20}$ grain (0.003 Gm.), and strychnine sulphate, $\frac{1}{30}$ gram (0.002 Gm.), administered hypodermically. Liepelt found it more active in this condition, if properly applied, than either chloral hydrate or morphine. In the **delirium of infectious diseases**, including **pneumonia**, **typhoid fever**, **septicemic**, etc., scopolamine is of value, especially where a feeble, dilated heart or pronounced circulatory impairment, *e.g.*, in alcoholics, contraindicate the use of chloral hydrate. For this purpose it should be used in moderate dosage— $\frac{1}{150}$ to $\frac{1}{100}$ grain (0.0004 to 0.0006 Gm.). If the first dose proves totally ineffective, or the delirium, as occasionally happens, is increased instead of diminished, the drug should not be further used. Similar considerations apply in the **insomnia of infectious diseases**. In pronounced **restlessness in neurasthenia**, scopolamine may also be used with advantage.

In **acute maniacal states** the use of scopolamine has, to a considerable extent, replaced that of morphine. According to H. S. Noble, in the **recurring** forms of **insanity**, maniacal attacks can often be averted with it. Such patients, at the first intimation of approaching excitement, are given an active cathartic, usually mercurial, followed by $\frac{1}{100}$ to $\frac{1}{75}$ grain (0.0006 to 0.0008 Gm.) of scopolamine hydrobromide morning and evening, rarely oftener. Little or no tolerance to the drug is established. In **agitated melancholia** Doerner found scopola-

mine often to bring about quietude when all other means had failed. The effect comes on rapidly and lasts from three to ten hours, according to the dose given. Insane patients are often more resistant to the effects of scopolamine than others, doses of $\frac{1}{64}$ grain (0.001 Gm.), or even more, being sometimes necessary; on the other hand, doses as small as $\frac{1}{250}$ grain (0.00025 Gm.) are sufficient in some instances. The absence of unpleasant after-effects is a marked advantage of this drug.

Among other nervous conditions in which scopolamine may be availed of are **status epilepticus**, **chorea**, **hysterical convulsions**, and the convulsions of **cerebrospinal meningitis**. Higier, in a case of obstinate chorea occurring in pregnancy, was able to control the movements by giving a $\frac{1}{60}$ -grain (0.001 Gm.) dose daily for a week. In **nervous asthma**, the same author had good results from the administration of $\frac{1}{250}$ to $\frac{1}{125}$ grain (0.00025 to 0.0005 Gm.) subcutaneously at the time of the attack, together with smaller doses during the intervals as prophylactic. In attacks of **hystero-epilepsy** Nagy usually obtained sedation in five to twenty minutes by means of an injection of $\frac{1}{64}$ grain (0.001 Gm.) of the drug. In **trigeminal neuralgia** with attacks of **muscular contracture**, Pont procured relief of pain and diminished frequency and duration of the attacks of contracture by giving daily injections, either into the cheek at the painful spot or into the arm, of $\frac{1}{320}$ grain (0.0002 Gm.) of scopolamine hydrobromide, four days' treatment being alternated with rest periods of equal duration. Noble found $\frac{1}{120}$ to $\frac{1}{100}$ grain (0.0005 to 0.0006 Gm.) of

scopolamine, given half an hour before retiring, of great value in controlling the spasmodic **cramps** sometimes experienced in the **lower extremities** on retiring, or upon stretching in the morning. The same author successfully employed $\frac{1}{75}$ grain (0.0008 Gm.) at night to arrest **excessive seminal emissions**. Higier found the drug valuable in **pruritus** of all kinds, except diabetic. It has also been used with benefit in **hiccough**.

In the **tremor of paralysis agitans** and in **senile** or **alcoholic tremor**, scopolamine yields prompt, though not always lasting, effects. It may be used in daily doses of $\frac{1}{240}$ to $\frac{1}{20}$ grain (0.00025 to 0.0005 Gm.), hypodermically, in these conditions, and may be given for a long period without habituation or detrimental effect. It has also been recommended in **multiple sclerosis**.

In the **night-sweats of pulmonary tuberculosis** and in **lead colic** scopolamine has also been used, with partial success.

For its use during withdrawal of morphine from habitués, the reader is referred to the article on Opium Habit.

As Mydriatic and Cycloplegic.—For refraction purposes scopolamine presents certain advantages over atropine, and is even preferred to the latter for routine use by some specialists. Two instillations of a drop each of a 1-grain (0.06 Gm.) to the ounce (30 c.c.) solution of scopolamine hydrobromide at an interval of half an hour are sufficient to produce complete mydriasis and cycloplegia in less than an hour after the first instillation. Even a 1 in 1000 solution is usually sufficient, especially if the

patient is required to instill it on the evening before and the morning of the day of consultation. The mydriasis and likewise the paralysis of accommodation pass off, according to the amount of drug used, individual sensitiveness, etc., in from two to four days, thus markedly shortening the period of disability experienced as compared to atropine. Pressure over the lower canaliculus after instillation is recommended to minimize the possibility of constitutional effects by preventing drainage of the drug into the lachrymal passages and nasal cavities, whence it is more rapidly absorbed.

In inflammatory infections of the eye, scopolamine is held to be equally as valuable, or more valuable, than atropine, and it is said not to increase intraocular tension. In **rheumatic** or **syphilitic iritis**, it may be combined with or substituted for atropine in instillations, and may also, with advantage, be given hypodermically at night to relieve pain. In **plastic iritis** scopolamine acts very energetically, often removing synechiæ, which atropine had failed to influence (Raehlmann). In **uveitis (serous cyclitis)**, scopolamine may be used in the absence of increased intraocular tension (De Schweinitz). It may also be substituted for atropine in **sympathetic ophthalmitis**.

MORPHINE-SCOPOLAMINE ANESTHESIA.—The first report on anesthesia produced by a combination of morphine with scopolamine was made in 1900 by Schneiderlin, an alienist, who, having used the drugs simultaneously for sedative purposes in restless, insane patients, with satisfactory results, proceeded to employ them to induce surgical anesthesia in

demented cases. The procedure is based chiefly on synergistic action of the two drugs as narcotics. Although the antagonism between them in certain of their other effects might be thought of marked advantage, permitting the use of large doses with the exclusive view of causing narcosis and eliminating apprehension of unpleasant side effects, this is true only to a slight degree, the opposite effects of the drugs on the pupil and heart rate having but little value, except as indications of the relative degree of action of the drugs in the individual case.

The experiences of Terrier, E. Ries, A. C. Wood, W. Wayne Babcock, and others, have shown that by subcutaneous injection of scopolamine and morphine alone, without any inhalation anesthetic, a satisfactory surgical anesthesia can, in many instances, be obtained. This is especially the case in the aged, debilitated, and cachectic. The young and robust, on the other hand, are resistant and show a tendency to excitement and delirium under scopolamine, which largely unfits them for this form of anesthesia. Babcock, substituting in young adults, for morphine and scopolamine (or adding to them) apomorphine, or an enema containing Hoffman's anodyne, alcohol, and sometimes paraldehyde, has found that one may produce general anesthesia in most persons over 18 years of age without resort to inhalation of ether or chloroform. The procedure proved very satisfactory—often giving results superior to any other form of anesthesia—in operations upon the head, neck, respiratory system, and spinal column. In abdominal and rectal operations, on the

other hand, and to some extent in operations on the hands and feet, it was found inferior owing to failure to abolish muscular rigidity and reflexes.

Morphine-Scopolamine Preliminary to Inhalation Anesthesia.—In spite of the numerous advantages of exclusive narcotic anesthesia, where applicable, the procedure is, in general, accorded only a small field of application because of the special care required to avoid serious respiratory depression—both during and for some time after the operation by the narcotics given—especially the morphine, and the relatively high mortality which has followed its application in unskilled hands. Injection of morphine and scopolamine in smaller amounts before anesthesia by ether or chloroform, on the other hand, is considered less dangerous and looked upon with much more favor. The dosage ranges from $\frac{1}{16}$ grain (0.01 Gm.) of morphine and $\frac{1}{120}$ grain (0.0005 Gm.) of scopolamine to twice these amounts, given either in one dose one-half to two hours before the time of operation or in divided doses. In small-sized patients, doses somewhat less than those mentioned may be given, *e.g.*, $\frac{1}{8}$ grain (0.008 Gm.) of morphine and $\frac{1}{150}$ grain (0.0004 Gm.) of scopolamine.

The procedure is advantageous in many ways, allaying the patient's apprehension, diminishing after-pain by lengthening the period of narcosis, and distinctly lessening postanesthetic vomiting. The inhalation anesthetic is taken quietly, rapidly, and without struggling, little or no secretion in the mouth and respiratory tract takes place, anesthesia is maintained with a very small expenditure

of the inhalation anesthetic, respiration is quiet and regular, and during the operation there is no vomiting or obstruction to breathing from fluid in the air-passages. While the pulse may be accelerated by the scopolamine, its quality remains good. The patient is able, where the part operated upon permits, to take water or even food shortly after awakening without nausea or vomiting. The procedure is especially valuable in neurotic subjects, and in patients with organic disease of the respiratory tract. A much larger dosage is required in alcoholic, strong men than in aged persons, and in the female sex.

According to Bürgi, substitution of pantopon (omnupon) for the morphine in the morphine-scopolamine combination is of advantage, in that the respiratory center is less influenced and the likelihood of vomiting. A $\frac{2}{3}$ -grain (0.04 Gm.) dose of pantopon, with $\frac{1}{150}$ to $\frac{1}{100}$ grain (0.0004 to 0.0006 Gm.) of scopolamine is held to be without danger in strong individuals of middle age, though in delicate or old persons with respiratory disturbances the dose of pantopon should be considerably less. Reichel and Keim, on the other hand, specifically mention respiratory depression as a possibility in the use of pantopon. Reichel much prefers to substitute for the latter narcophine, a meconic acid compound of morphine and narcotine. Keim has found thirst a troublesome symptom after pantopon-scopolamine anesthesia.

Morphine-Scopolamine Preliminary to Local and Spinal Analgesia.—In local and spinal types of analgesia the patient remains alert and apprehensive, and at times has trouble,

especially under local analgesia, in keeping himself under control. To overcome this difficulty and facilitate the surgeon's work, as well as in local analgesia, which is frequently incomplete, to reduce the shock to the nervous system from tissue injury by dulling the sensibility of the sensory centers, morphine and scopolamine may be employed to great advantage. W. Wayne Babcock usually orders administered, one hour and a quarter before the induction of spinal anesthesia, $\frac{1}{16}$ grain (0.01 Gm.) of morphine sulphate and $\frac{1}{100}$ grain (0.0006 Gm.) of scopolamine hydrobromide. Where, shortly after, the patient is not in a condition of distinct drowsiness (though still showing some response when spoken to), an additional dose of each remedy is given twenty minutes after the first. If, as is the case in a few instances, the effect is still insufficient, a third dose is given, sometimes of only one of the drugs, stress being laid rather on the morphine in young and on the scopolamine in older subjects. Before major operations under local anesthesia, in which a deeper soporific effect is, in general, of advantage, Babcock supplements the morphine-scopolamine administration with a narcotic enema consisting of Hoffman's anodyne (Spiritus ætheris compositus, U.S.P.), $\frac{1}{2}$ to 1 fluidounce (15 to 30 c.c.); paraldehyde, 2 fluidrams to $\frac{1}{2}$ fluidounce (8 to 15 c.c.), and water, 5 fluidounces (150 c.c.). At the conclusion of the operation 2 quarts (liters) of normal saline solution are introduced in the bowel to accelerate elimination of the narcotics. By these means the patient operated under local anesthesia passes through the operation without being conscious of

any pain, or at least, if pain is experienced, recollection of it after the operation is completely or largely blotted out.

Morphine-Scopolamine in Obstetrics.—The combination of morphine and scopolamine was first employed in obstetrics in 1903 by Steinbuechel, merely to reduce the pain attending labor, without producing any degree of narcosis. The procedure definitely intended not only to reduce suffering, but also to banish the memory of pain after the completion of labor was, however, elaborated by C. J. Gauss, of Krönig's clinic in Freiburg, who in 1907 reported 1000 cases in which this method had been successfully applied. In the following year Krönig reported a series of 1500 cases, in which one child had died during delivery and three others in the first three days after delivery. Thereafter it was not until a more recent favorable report of 5000 cases had been made by Gauss that widespread interest in the method was reawakened.

The price of success and relative safety in the use of this procedure is held by many to be a rigid adherence to the somewhat complex and pains-requiring original method of Gauss, who, in the process of obtaining a simple state of amnesia with partial insensibility to pain,—the so-called **twilight sleep** (Dämmer Schlaf),—carefully adjusts the dosage to the individual case by means of a "memory test" carried out at intervals during the course of labor. In primiparæ, the first sedative injection is given when good uterine contractions are taking place every four or five minutes and persisting at least one-half minute. This injection con-

sists of 0.01 Gm. ($\frac{1}{8}$ grain) of morphine hydrochloride, and 0.00045 Gm. ($\frac{1}{400}$ grain) of scopolamine hydrobromide, injected separately into the buttock or thigh. Three-quarters of an hour later, the same dose of scopolamine is repeated alone. One-half hour after, a memory test is used, the patient being asked how many injections she has had, and if she remembers some strange object, such as a drinking-cup, exhibited to her at the time of the first injection. The memory test is repeated thereafter, using new objects each time, every half-hour, and if memory is still present one and a half hours after the second injection a third injection of scopolamine, 0.0003 Gm. ($\frac{1}{200}$ grain) only, is given. Subsequent memory tests may indicate additional injections of scopolamine, but these should be small, and given only at long intervals. No additional morphine is administered after the first dose. To permit the development of a proper "twilight sleep," absolute quiet and plugging of the patient's ears and covering of her eyes are of importance. The maternal pulse, pupil reflexes, and temperature, as well as the fetal heart rate, are to be taken every half-hour so quietly that the patient's state of sopor will not be disturbed.

In order to increase the field of availability of the method, Siegel has elaborated a modified Gauss technique in which the attempt to individualize the dosage is abandoned, a standard routine dosage being prescribed, and no memory tests used. When labor is definitely established, the first injection is given, consisting of narcophine (morphine and narcotine meconate), 0.03 Gm. ($\frac{1}{2}$ grain), and scopolamine hydrobromide, 0.00045

Gm. ($\frac{1}{400}$ grain). This is followed in three-quarters of an hour by 0.0003 Gm. ($\frac{1}{200}$ grain) of scopolamine alone, and in three-quarters of an hour more by narcophine, 0.015 Gm. ($\frac{1}{2}$ grain), and scopolamine, 0.00015 Gm. ($\frac{1}{400}$ grain). The sedative action is thereafter maintained by repeating the scopolamine in 0.00015 Gm. ($\frac{1}{400}$ grain) doses every two hours. Repetition of the narcophine is seldom required, though it may be given at six-hour intervals in a prolonged labor.

Opinions as to the value of morphine or narcophine-scopolamine administration in obstetrics vary from enthusiastic advocacy of the measure as a routine procedure—barring certain definite contraindications—to complete condemnation. B. C. Hirst summarizes the disadvantages of the method as "prolongation of labor, tendency to atony of the uterus with hemorrhage, and an increased proportion of apneic babies that could not be revived." With minimum doses of the two drugs these disadvantages disappeared, but the relief afforded was scarcely noticeable. He found the method of value, however, chiefly for its psychic effect, in neurotic primiparæ in whom a long, painful labor is considered probable. J. C. Applegate noted very satisfactory results in a small percentage of cases, but accords the method only a limited field in obstetrics. Polak, on the other hand, has reported a series of 155 cases with but three failures, no fetal mortality, and no post-partum hemorrhage. He asserts that narcotization of the child (beyond oligopnea for a few minutes), if encountered, is not the fault of the method, but of the dosage and man-

ner of applying it, and that the actual fetal mortality is lessened, rather than increased, by the procedure. In primiparæ of the physically unfit type, commonly becoming exhausted at the end of the first stage of labor, the method brings necessary rest between contractions, obviates exhaustion, and greatly reduces the proportion of cases requiring high or medium forceps application. In border-line disproportion cases, if operative delivery becomes necessary, this can be done with less shock and less general anesthesia. In cardiac and tuberculous cases, Polak uses the method to reduce the strain placed on the circulation in the first stage of labor. Contraindications to its use are emergency conditions, such as precipitate labor, placenta previa, accidental hemorrhage, eclampsia, prolapse of the cord, primary inertia, and a dead fetus. The procedure may be applied, however, in the first stage to secure dilatation in malpositions, scopolamine, properly used, having been shown to favor dilatation of the cervix and reduce uterine spasticity. It does not diminish mammary secretion.

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SCORBUTUS.—Scorbutus, or scurvy, is a constitutional disorder, dependent upon a deficiency of vegetable food, and characterized by a peculiar form of anemia, great mental and bodily prostration, spongy gums, a tendency to the occurrence of mucocutaneous and subperiosteal hemorrhages, and a brawny induration of the muscles, especially those of the calves and the flexor muscles of the thighs.

Scorbutus has almost totally disappeared owing to the wise laws enacted by the various maritime countries, based on the discovery that deprivation of certain

substances present in fresh fruit and vegetables is the underlying cause.

SYMPTOMS.—The early symptoms of scorbutus are a rapidly progressive anemia, the surface becoming dirty-looking, sallow, pallid, or earthy in appearance; a gradually increasing debility, emaciation, and indisposition for bodily and mental exertion; arthritic and muscular rheumatoid pains in the limbs and back; mental apathy or depression; dyspnea upon slight exertion; the tongue may continue clean, but it becomes large, pale, flabby, and indented by the teeth. The appetite usually remains good. The bowels, as a rule, are constipated.

Other manifestations now appear. Pectechial spots arranged about the hair-follicles are observed, first on the lower extremities, later on other parts of the skin surface. These spots are followed by large subcutaneous extravasations and puffy swellings in various parts of the body, apparently due to deep-seated copious hemorrhages, as, later, the surface over them becomes ecchymotic. These swellings chiefly occupy the popliteal spaces, the anterior aspects of the elbows and of the lower part of the legs, the space behind the angles of the jaw, and the loose connective tissue in and about the eyelids, giving them a puffy, bruised-like appearance, and often accompanied by a sanguineous accumulation in the subconjunctival tissue covering the eyeball.

The gums now begin to swell, especially at the edges, become spongy and lobulated, rising sometimes above the teeth and concealing them. They are deep-red or livid in color, bleed easily, ulcerate or slough, and give rise to an exceedingly fetid odor. The teeth often become loose and, in exceptional cases, drop out. A tendency to ulceration or sloughing becomes more or less general in all parts of the cutaneous surface, more especially at the locations of the puffy swellings, being easily induced by a slight scratch, pressure, or blow.

The anemia increases. The face becomes puffy and anasarca, more or less marked, appears in the lower extremities; dyspnea develops; the heart-action becomes feeble and irregular, and the pulse small, soft, and, on exertion, much ac-

celerated. The slightest exertion excites attacks of sudden syncope, which may be fatal.

Late in the disease the appetite is apt to fail; the bowels become loose, the stools being usually very offensive, and, not infrequently, containing blood; nervous symptoms are now manifest; visual disorders, including hemeralopia and nyctalopia, tinnitus aurium, vertigo, insomnia, and late delirium may be present; meningeal hemorrhage may occur. The intellect usually remains unaffected.

During the progress of the disease thoracic complications may appear, such as pleurisy with effusion (often bloody), pulmonary congestion with extravasation of blood into the lung-tissue, bronchial congestion, cough, and blood-stained sputa, having, not infrequently, a gangrenous odor.

The urinary symptoms vary. Albuminuria is not rare. The specific gravity of the urine is increased, the color high, the solids diminished, excepting the phosphates, which are usually larger in amount. Nephritis may occur.

The bones in chronic cases may become congested, or even necrotic, and the epiphyses separate from the shafts.

The duration of scurvy may be several weeks or months. Death commonly results from sudden syncope or from gradual asthenia, hastened, in some cases, by the occurrence of ulceration, hemorrhage, thoracic affections, or other complications.

DIAGNOSIS.—The diagnosis is made from the history, the peculiar facies, the spongy and swollen gums, the gingival and deep-seated cutaneous hemorrhages, the increasing loss of strength and energy, the mental depression, and the rapid response to correct treatment.

From purpura hemorrhagica it is distinguished by its chief causative factor—a diet lacking in fresh vegetables and fruits—by the spongy, swollen gums, loosened teeth, and the brawny induration of the limbs. In purpura hemorrhagica, the ecchymotic spots are not arranged around a hair-follicle, and the hemorrhages from the mucous membranes are greater in amount.

ETIOLOGY.—In former times scorbutus was prevalent among sailors on pro-

longed voyages, in armies in active service, and among people suffering from famine. According to Osler, the disease is not infrequent among the Hungarian, Italian, and Bohemian miners in Pennsylvania. It is rarely epidemic. It is, however, endemic, especially in parts of Russia (Hoffman) and elsewhere, sweeping through prisons, barracks, almshouses, and institutions of like character.

The chief predisposing cause is a long-continued dietary, lacking in certain essential but obscure substances found in fruits and fresh vegetables. Unhygienic surroundings, excessive muscular exercise, humidity, cold, and other debilitating influences are recognized as etiological factors. Testi and Beri have isolated a micro-organism which they believe to be pathogenic.

PATHOLOGY.—The pathology of scorbutus corresponds to the symptoms. Microscopic examination of the blood reveals the presence of profound anemia; the blood is of low specific gravity, thin and dark, contains an excess of fibrin, less hemoglobin, and fewer red blood-cells, but there is no leucocytosis. The skin may be the seat of ecchymoses (subcutaneous hemorrhages), but the most characteristic hemorrhage is that under the periosteum of the femora. Extravasations of blood, in various stages of transformation, may also be found in the lung-substance, beneath the pleura, in the heart-muscle, in the subpericardial tissue, in the intestinal parietes, and beneath the peritoneal membrane. Blood-stained serum may be found in the various serous cavities. The internal organs may, or may not, be congested. The brain is usually intact. The heart, liver, and kidneys are, occasionally, the seat of parenchymatous or fatty degeneration.

PROGNOSIS.—If the disease has not progressed too far and appropriate treatment is available, the prognosis is good; otherwise, the outlook is grave. The internal symptoms, especially the pulmonary, are more serious than the external ones. Pneumonia, hemorrhagic infarct of the lung, pleurisy with bloody effusion, acute nephritis, or dysentery, is usually followed by death.

TREATMENT.—Prophylaxis demands an adequate supply of antiscorbutic food

for long seavoyages, military campaigners, and explorers in the frozen zones. This is facilitated by the present-day abundance of canned fruits and vegetables, though canning may reduce their value.

In the treatment of the disease the two indications are to provide a **diet of citrus fruits** and of **vegetables** containing the necessary antiscorbutic vitamins or salts, and to combat special symptoms and complications. The use of the juice of two or three **lemons** or **oranges** daily will be followed by marked improvement.

If the digestion is feeble give **orange- or lemon- juice** combined with **meat-juice** or **egg-albumin**, milk and farinaceous foods. When the condition improves, the stronger animal foods and fresh antiscorbutic vegetables, such as potatoes, water-cress, raw cabbage, onions, carrots, turnips, **tomatoes** and sauer kraut should be used freely.

Orange peel has been found to be antiscorbutic. According to A. F. Hess, **boiled orange juice**, given intravenously, acts like a charm in scurvy.

Ulcerations in the mouth may be healed by using a mouth-wash of **boric acid** solution. To relieve the swollen, spongy gums a 2 per cent. solution of **tannic acid**, or a mouth-wash containing **boric acid**, **tincture of myrrh**, and **compound tincture of benzoin** may be used.

Twelve cases of scurvy in the Idiot Cottages at Kew, Victoria, all in cripples confined to bed or chair, of both sexes. There had been no alteration in the dietary of the patients for years. Other patients suffering from the same crippled conditions and with the same foods were unaffected. The scurvy cleared up in the majority of cases shortly after the patients received a special dietary of **raw eggs**, **lime water**, **lemon juice** and **raw milk**. Lind (Med. Jour. of Austral., Aug. 9, 1919).

S. and W.

SCORBUTUS, INFANTILE.

See INFANTILE SCORBUTUS.

SCROFULA. See various forms of TUBERCULOSIS.

SCROFULODERMA. See TUBERCULOSIS OF SKIN.

SEASICKNESS.— D E F I N I -

TION.—Seasickness may be defined as an indisposition, characterized by giddiness, nausea, vomiting, and depression, produced by the motion of a vessel on the waves. Closely allied and somewhat similar conditions are elevator- and car- sickness. Regnault recognizes two forms of seasickness, the somatic (gastric) and the psychological (nervous), or that which is the work of the imagination or results from seeing others affected.

SYNONYMS.—Seasickness is also known as naupathia; nausea marina seu maritima; morbus maritimus (L.); mal de mer, naupathie (F.).

SYMPTOMATOLOGY.—De Vries recognizes four stages: depression, exhaustion, reaction, and convalescence. In mild cases the patient is but slightly ill, suffering from malaise and giddiness, followed by tinnitus, headache, yawning, and drowsiness, with some gastric distress. In more severe cases, nausea, vomiting, vertigo, anorexia, moderate prostration, a greenish or grayish pallor, and unsteadiness of gait are present. In the very ill great prostration may supervene. Constipation or diarrhea may be present. All the secretions are diminished (including the menses) except the saliva, the flow of which may be excessive. Diplopia, pain in the eyes, scotoma, staggering gait, muscular relaxation, backache, neuralgic pains, alternating warm flashes and chilliness, weak and rapid pulse, clammy skin, profuse diaphoresis, insomnia, fear, and a feeling of general depression are commonly noticed. There are more often mental depression, nervous exhaustion, unpleasant delusions of the senses of taste and smell, and, more

rarely, deficient intellectual control. One of the first symptoms in certain cases is an abnormal appetite, which appears as soon as rough water is encountered.

COMPLICATIONS AND SEQUELÆ.—Cerebral hemorrhage or the rupture of a previously existing gastric ulcer is not infrequent. Brewer, U. S. A. Medical Corps, mentions a case in which the vomiting was so severe that a vessel in the stomach was ruptured and considerable blood lost; the child was ill for several days after landing. He reports another case in which a physician who, in addition to the usual symptoms, suffered from a severe diarrhea whenever the sea was rough.

Among the most frequent sequelæ are vertigo, anorexia, constipation, nervousness, and invalidism, these symptoms persisting after the patient has left the ship. Bushby, of Liverpool, reports two cases of severe, prolonged prostration following seasickness and associated with acetouria. Beard mentions the case of a man, sick an entire year at sea, who could not enter any place where the air was foul without feeling the symptoms of seasickness.

ETIOLOGY.—The etiology of seasickness is far from being absolutely settled. Many theories have been advanced, of which the "endolymph theory" is the most generally accepted one. According to William Edgar Darnall the motion of the waves with the rhythmic intervals becomes transmitted to the endolymph of the semicircular canals. This continual flowing in a given plane over-irritates the fine hair-like terminals of the vestibular nerve in the labyrinth, and reflexes are sent to the vomiting

center, which, with the nuclei of the eighth nerve, also lies in the fourth ventricle. There follows obstinate vomiting, often associated with great prostration. The endolymph follows the motion of the head in those canals whose plane corresponds most nearly to the direction of that motion, and when the motion is suddenly reversed by the oscillation of the ship, or changed in direction by a new wave striking her on another point, the endolymph continues in its original direction until stopped by friction. This causes undue pressure in one or more of the ampullæ, by which wrong impressions are conveyed to the sensorium, and inco-ordination and giddiness result. Moreover, the otoliths are washed up against the nerve filaments at the front of the semicircular canals and produce an excessive irritation, which is expressed in vertigo and vomiting. James L. Minor, of Memphis, calls attention to the freedom of deaf-mutes from seasickness as a proof of its aural origin, adding that nausea and dizziness are results of irritated, but not destroyed (as in deaf-mutes), semicircular contents.

The theory that "anemia of the brain" causes seasickness was advanced by C. Binz, of Bonn. He claims that (1) the motion of the ship causes constriction of the arteries of the brain and consequent anemia of that organ; (2) this acute, local anemia gives rise, as at other times, to rapidly recurring nausea and vomiting; (3) the retching and vomiting then increases the volume of blood in the brain and, in that way, relieves the cerebral anemia and removes the sense of nausea; (4) the stomach plays a passive rôle, being influenced

by the central nervous system to act whether it is empty or full; (5) everything that facilitates the flow of blood to the brain, and increases the same, acts as a prophylactic, mitigates, or cures the seasickness.

Germane to this is the "theory of Pflanz," that the constant change in blood-pressure and in the fullness of the blood-vessels produces an irritation in the brain which, when it passes the stage at which it can be borne, evokes the characteristic symptoms of this condition.

Metcalf Sharpe suggests that the condition is the result of a reflex action of the stomach due to a central stimulus; the reflex action is transmitted to the solar plexus by the vagi; the stimulus probably originates in disorders of visual accommodation, for by paralyzing the accommodation of one eye, by means of a mydriatic, he found that the symptoms were greatly lessened. Hewitt, of London, believes that interference with the visual center predisposes to seasickness.

According to W. Janowski seasickness is an expression of a mild form of oft-repeated cerebral concussion.

The surprise of the mental faculty underlying consciousness, analogous to strong emotional disturbance, as fright, joy, etc., is given by Losee as the causative agent in this disorder.

Dastre and Pampoukis believe that there is a combination of etiological factors, of the central nervous system, the pneumogastric, the splanchnic, and the phrenic nerves, and that the displacement of the abdominal viscera and their slipping motion on each other probably cause stimulation of the Paccinian bodies of the mesentery, the effect of which is ex-

pressed in nausea and alteration in the respiratory movements.

Dubois ascribes a causal relation to incomplete ventilation of the lungs, with an increase in residual air, and imperfect respiratory changes. The secondary phenomena, headache, vomiting, and chills are referred, etiologically, to the spasmodic and forcible contractions of the diaphragm with a consequent displacement of the viscera.

Kenneth F. Lund, of Dublin, after reviewing the various theories as to the causation of seasickness concludes that (1) the vomiting is not due to the unusual impression of vision, for it may occur on land, when the eyes are closed, and even to the blind; (2) it is not due to smell, as any unpleasant odor may cause vomiting, and may occur on land, and to any, including deaf-mutes, who have sensitive nasal organs; (3) it is not due to momentary displacement of viscera, for it occurs in swinging or in descending upon an elevator. The sensation is present whether the eyes are open or closed, but it does not occur in deaf-mutes; (4) there is some mechanism in the auditory organ, perhaps the semicircular system, which is directly affected by the oscillations of a vessel at sea, which acts as a stimulus to the vomiting center.

Finally, the nervous element and power of the imagination, as causative factors, should not be disregarded, especially in those of a highly sensitive and nervous temperament.

Age has some etiological importance. Children and the very aged rarely suffer from it, although children may, purely out of sympathy. Females are more frequently affected than males. Only from $\frac{1}{2}$ to 5 per

cent. of all persons escape. Gihon estimates that 5 per cent. are immune, that 25 per cent. are but little sick, that 60 per cent. are a great deal sick, and that 10 per cent. are distressingly ill.

PROGNOSIS.—Seasickness is seldom, in itself, a menace to the life of a patient.

PROPHYLAXIS.—Choose a favorable season (spring or summer), if possible, for the voyage. Avoid sailing on the long, narrow ocean-greyhounds which roll with each swell and pound the ship into constant motion with their powerful engines, but select, rather, one of the broad-beamed, slow-going boats which are now so well fitted for the comfort of the passengers, as well as carrying freight. Select stateroom and deck quarters in the middle of the ship, near its transverse axis, the point where the rolling of the vessel is least felt. A thorough hepatic purge should be taken the night before embarking, and a saline on the following morning. Go on board the vessel rested in body and with a tranquil mind, after a light meal on shore, with which a little wine was taken, but scarcely any other fluids.

The clothing should be of light, pure, woolen material; easy, warm, comfortable, broad-soled shoes should be worn. A good flannel roller bandage, 12 feet long and 6 inches wide, enveloping firmly the whole abdomen will frequently afford great comfort and prevent undue movement of the viscera.

A steamer-chair and rug should be provided. Recline on deck in a sheltered place, amidship, on the leeward side, comfortably covered and with eyes closed. If cerebral congestion

should occur, raise the head or sit up awhile. Keep always in the cool air on deck with pleasant companions, save for meals and bed, moving about as little as possible, until accustomed to the ship's motion. Avoid oleaginous smells and the company of those who are seasick, as suggestion is a powerful excitant to seasickness.

Avoid cold food. Vichy and Apollinaris waters may be freely indulged in throughout the voyage. Small and frequent (at least seven) meals are best. M. Charteris, of Glasgow, insists that the diet for the first two days should be dry and spare, no full meals being taken, and soups and pastries always avoided. If there is any tendency to nausea, exertion should be avoided, as much as possible; the sufferer should be on his back, with a small pillow under the head, or none.

As to drugs suggestions are numerous. No drug or combination of drugs is infallible. A. D. Rockwell, of New York, strongly advises **bromization**—100 grains (6.6 Gm.) in divided doses daily for three days before sailing, and for three or four days after sailing. **Veronal (sodium)**, a favorite with many, is best given in a suppository containing $7\frac{1}{2}$ grains (0.5 Gm.), although 5-grain (0.3 Gm.) doses may be given in tablet form, by mouth. **Chloretone**, another favorite remedy, may be given in 5-grain (0.3 Gm.) capsules, tablets, or powders, every 3 hours for 3 doses, so arranged that the last shall be taken on embarking. For short voyages this is usually effective; for longer ones the drug should be continued longer. **Validol**, highly recommended by many, is best given in liquid form on a lump of sugar, the first dose be-

ing 30 drops, the second 25 drops, and the third 15 drops, taken an hour apart, the first dose two or three hours before sailing. It may also be taken in doses of 10 to 15 minims (0.6 to 1 Gm.), repeated half-hourly, if required, plain (neat), in a weak, alcoholic solution, or in liquid form. A prophylactic injection of $\frac{1}{100}$ grain (0.0006 Gm.) of **atropine sulphate**, combined with $\frac{1}{50}$ grain (0.0012 Gm.) of **strychnine sulphate**, as suggested by Girard and others, will do much to inhibit the onset. Avoid the use of morphine, cocaine, and paregoric, which at times are thoughtlessly recommended.

TREATMENT.—Whenever the slightest sensation of illness is felt lie down at once and close the eyes. Usually one pillow suffices, and if very ill, none should be used. Two teaspoonfuls of **peptone in sherry wine**, poured over cracked ice, may be given every half-hour, as suggested by Sinclair Tousey. If the patient is very ill and cannot eat or retain food, H. Partsch recommends an **egg-nog**, prepared by mixing the yolks of two raw eggs with an equal bulk of good brandy or sherry well-beaten together, and given in teaspoonful doses at ten-minute intervals. Patients with severe retching will be made comfortable by lying down, without a pillow, the eyes closed; a pint of **beer, ale, or porter** (brown stout) is then taken in six or eight portions at five-minute intervals. **Champagne frappé** or **ginger ale** with 20 per cent. of **brandy** or **whisky** is highly praised by many. When champagne is used it is advisable to allow it to stand until effervescence ceases, that eructations be avoided. **Beef-tea** or **meat broths**, in

tablespoonful doses, may be retained. Food should always be taken at least ten minutes before arising in the morning, and when the patient is ill all food should be taken without raising the head. The best time to take any beverage or food is just after a paroxysm of retching. Should it be taken before and vomited, then take another dose immediately afterward, and that will stay down (H. Partsch). The sicker the patient, the oftener he must eat, and the less at a time. The bowels should be kept open by **laxatives** or **warm-water enemas**.

The drugs most in favor in this condition are **veronal**, **chlorotone**, **validol** (the administration of which has been already described under prophylaxis), **atropine**, **atropine** and **strychnine** combined, **nitroglycerin** (spiritus glycerylis nitratis), and **amyl nitrite**. The bromides have largely fallen into disuse, except for relieving the headache, because they tend to disorder the digestion.

Atropine is given, to increase the cerebral blood-supply and to relieve atony of the vagus, hypodermically, in doses of $\frac{1}{120}$ to $\frac{1}{60}$ grain (0.0005 to 0.001 Gm.), to be repeated in three or four hours, if necessary. **Atropine sulphate**, $\frac{1}{120}$ grain (0.0005 Gm.) may be advantageously combined with $\frac{1}{60}$ grain (0.001 Gm.) of **strychnine sulphate**.

Nitroglycerin and **amyl nitrite** have been used in full doses.

Rosenthal has shown that every reflex action can be prevented by **apnea**. This principle is applied for the suppression of the vomiting (which is due to a reflex stimulation of the center in the fourth ventricle) by directing the patient to take a series of **deep inspirations**. The suc-

cessful experiments of Rosenthal have been repeated by R. Heinz and M. Kaufmann.

Bier's method of hyperemia has been successfully used by Rosen and by Schläger to relieve the nausea of seasickness. The hyperemia was induced by fixing an **elastic band around the neck**. This had no influence on the tendency to vomit when the stomach was full, but when the stomach was empty the tendency to vomit ceased. The band was always removed at night.

Based on his theory (see Etiology) M. Dubois advised **inhalations of oxygen** under pressure, through the mouth. These were followed by rapid improvement. The number of inhalations was not very large, the amount of gas inhaled being usually from 30 to 40 liters. Dutremblay and Perdriolat attest the efficiency of this treatment.

Wolf applies **hot-water compresses** to the forehead, as hot as can be borne, and rapidly alternated. They are at first badly tolerated, but after a little time they produce a thorough sense of relief. **Adrenalin** given internally has also been praised.

Although the number of cases in which the writer used **benzyl benzoate** in seasickness is small, about 20 in all, the results in every case were so satisfactory that he feels justified in recommending it. In his cases 10 drops were used. As the sea voyage was short in all cases, he was not able to determine how long the effect of the drug would last. Glenn (Calif. State Jour. of Med., Nov., 1920).

C. SUMNER WITHERSTONE,
Philadelphia.

SENEGA.—Senega (senega, snake-root) is the dried root of *Polygala senega* (fam., Polygalaceæ), a perennial herb of eastern and central North America, as far

south as North Carolina. The constituents of senega are a saponin-like mixture made up of polygallic acid (about three-fourths of the whole) and senegin, a small amount of methyl salicylate, resin, fat, sugar, etc. It contains neither tannin nor starch.

PREPARATIONS AND DOSES.—

Senega, U. S. P. (the dried root). Dose, 10 to 20 grains (0.60 to 1.20 Gm.).

Fluidextractum senega, U. S. P. (fluid-extract of senega). Dose, 10 to 20 minims (0.60 to 1.20 c.c.).

Syrupus senega, U. S. P. (syrup of senega)—20 per cent. of the fluidextract). Dose, 1 to 2 drams (4 to 8 c.c.).

Syrupus scilla compositus, U. S. P. (compound syrup of squill, hive syrup, croup syrup, an official substitute for Cox's hive syrup, containing 8 per cent. fluid-extracts senega and squill, and 0.2 per cent. tartar emetic). Dose, 10 to 30 minims (0.60 to 2.0 Gm.).

Mistura pectoralis, Stokes, N. F. (Stokes's expectorant). Dose, 1 dram (4 c.c.), containing 2 grains (0.12 Gm.) each of senega and squill, 1 grain (0.06 Gm.) of ammonium carbonate, and 10 minims (0.6 c.c. of paregoric in syrup of Tolu. This is a favorite mixture, though not official.

PHYSIOLOGICAL ACTION.—Senega is an expectorant, alterative, diaphoretic, and diuretic. The powdered root is irritating to the air-passages and its inhalation causes sneezing. When the root is chewed a burning sensation follows. When swallowed in large doses it causes salivation and gastrointestinal and renal irritation. It is an irritant to the skin. Used as an expectorant, it does not liquefy the secretions, but merely facilitates their expulsion; senega, therefore, is of little use when the expectoration is tough and scanty. It is usually combined with other expectorants and diuretics. Senega is excreted by the bronchial mucous membrane, the skin, and the kidneys, exerting a stimulating action upon these organs.

THERAPEUTIC USES.—Senega is chiefly used in **subacute and chronic bronchitis**, in the **chronic bronchitis of the aged**, often associated with emphysema, and by some in **croup**. In **bronchial asthma with emphysema**, the drug is

beneficial. **Whooping-cough** is sometimes relieved by senega. On account of its diuretic action senega has given relief in the **dropy of renal disease** and in **palpitation** unassociated with cardiac disease. In **amenorrhea** it has given good results. The use of senega in heart disease is not advised on account of the depressing action of its active principle. In doses of 2 grains (0.13 Gm.) senega has been given to check **uterine hemorrhage**. Senega has been given in **chronic rheumatism** for its diaphoretic and diuretic effects.

SENNA.—Senna is the leaflets of *Cassia acutifolia* (Alexandria senna) and *Cassia angustifolia* (India senna), family Leguminosæ, freed from stalks, discolored leaves and other admixtures. The principal constituents, according to Tschirch, are one or more glucosides, yielding emodin, an extractive substance (cathartic acid) and a large amount of gum resin, the non-fermentable sugar cathartomannite, a bitter (sennapicrin), oxalic, malic and tartaric acids combined with calcium, and a trace of volatile oil. Senna has a faint, disagreeable odor and a bitter, nauseous taste.

PREPARATIONS AND DOSES.—*Senna*, U. S. P. (senna leaves). Dose, 1 to 2½ drams (4 to 10 Gm.).

Fluidextractum sennæ, U. S. P. (fluidextract of senna). Dose, ½ to 1 dram (2 to 4 c.c.).

Infusum sennæ compositum, U. S. P. (black draught, containing 6 per cent. senna, 12 per cent. manna and magnesium sulphate, and 2 per cent. bruised fennel seeds). Dose, 2 to 4 ounces (60 to 120 c.c.).

Syrupus sennæ, U. S. P. (syrup of senna, containing 25 per cent. of fluidextract). Dose, 1 to 2 drams (4 to 8 c.c.).

Pulvis glycyrrhizæ compositus, U. S. P. (compound licorice powder, containing 18 per cent. senna, combined with washed sulphur, licorice powder, fennel oil, and sugar). Dose, ½ to 2 drams (2 to 8 Gm.).

Efficient but unofficial preparations are:

Confectio sennæ, N. F. (confection of senna, containing the pulps of cassia fistula, prune, tamarind, and fig, with 10 per cent. senna flavored with coriander oil). Dose, 1 dram (4 Gm.).

Syrupus sennæ aromaticus, N. F. Dose, 2 drams (8 c.c.), representing 15 grains (1 Gm.) deodorized senna, 6 grains (0.4 Gm.) jalap, and 2 grains (0.13 Gm.) rhubarb, with aromatics.

Syrupus sennæ compositus, N. F. Dose, 2 drams (8 c.c.), representing 16 grains (1.04 Gm.) senna and 4 grains (0.26 Gm.) each of rhubarb and frangula.

PHYSIOLOGICAL ACTION.—Senna is an active, but not acrid, cathartic, acting in about four hours and producing copious, yellow stools, with some griping which may be avoided by combining it with aromatics. It is a feeble hepatic stimulant, rendering the bile more watery. The menstrual flow may be excited by it, and if given to a nursing woman her milk thereby becomes a purgative. Injected into the veins it causes vomiting and purging, and in overdose a drastic cathartic, but it never produces poisonous effects. The urine acquires a red color from senna medication, if it is acid, but in an alkaline urine the normal yellow color is more pronounced.

THERAPEUTIC USES.—This drug is a safe, efficient, and, when combined with other drugs, a pleasant cathartic for **constipation**. For children and pregnant women the confection and the compound licorice powder are advised. It is contraindicated in threatened abortion, hemorrhoids, and where the intestines are inflamed.

SEPSIS, SEPTIC FEVER, SEPTIC INFECTION, SEPTIC POISONING, SEPTICEMIA. See **WOUNDS, SEPTIC.**

SEPTUM, DISEASES OF. See **NOSE AND NASOPHARYNX, DISEASES OF.**

SERA. See **Diseases in which these are used; also HEMATOLOGY.**

SERPENTARIA.—Serpentaria is the dried rhizome and roots of *Aristolochia serpentaria*, Virginia; or of *Aristolochia reticulata*, Texas (fam., Aristolochiaceæ). The Virginian species may be found throughout the eastern United States, and is chiefly collected in the mountainous districts south of Pennsylvania and

the Ohio River. *Serpentaria*, an aromatic bitter, contains a volatile oil (0.5 to 1 per cent.), a bitter principle, tannin, starch, sugar, gum, and resin. It has a warm, pleasant taste.

PREPARATIONS AND DOSES.—*Serpentaria*, U. S. P. (the crude drug). Dose, 10 to 30 grains (0.60 to 2 Gm.).

Fluidextractum serpentariae, N. F. (fluid-extract of *serpentaria*). Dose, 10 to 30 minims (0.60 to 2 c.c.).

Tinctura serpentariae, N. F. (tincture of *serpentaria*, 20 per cent.). Dose, $\frac{1}{2}$ to 2 drams (2 to 8 c.c.).

PHYSIOLOGICAL ACTION.—*Serpentaria* has a stimulating effect upon gastric secretion and is added to other drugs to increase their absorption and activity. It has a mild diuretic and diaphoretic action. In larger doses it produces a sense of fullness in the head, nausea, vomiting and intestinal griping with frequent evacuations of semisolid stools. Hemorrhoids are irritated and menstruation stimulated. It is also an expectorant.

THERAPEUTIC USES.—*Serpentaria* is a good general tonic. It is seldom used alone. In **atonic dyspepsia** it is useful, combined with the compound tincture of cinchona. In combination with the aromatic spirit of ammonia it is beneficial in **pneumonia of a low type**, in **bronchial catarrh**, and in **capillary bronchitis**. It is valued as a restorative in **typhus** and **typhoid fevers**. It has been used with benefit in **chronic rheumatism**, combined with other remedies. *Serpentaria* has given good results in **amenorrhea** dependent upon anemia or chlorosis.

SHINGLES. See HERPES ZOSTER.

SHOCK. — DEFINITION.—A general depression of the vital functions due to traumatism, a profound emotion, fear, etc., characterized by chemicophysical disturbances in the nervous system, in which deficient adrenal activity and vasomotor paresis are prominent features.

SYMPTOMS.—Shock may present itself in forms varying in intensity from slight depression to profound collapse approximating death. In severe shock the temperature is subnormal, the surface is pale or livid and cool or cold, the skin

being clammy and perspiring freely; the eyes are staring or half-closed; the respiration is shallow and irregular, and often gasping; the pulse weak, rapid and compressible or imperceptible. A notable fall of the blood-pressure is usual. These symptoms in severe cases are accompanied by loss of consciousness; in the less severe cases, consciousness is maintained as a rule, but psychic activity appears to be inhibited, the answers to questions being monosyllabic and often unreliable; even in mild shock mentality may be temporarily dull and apathetic. Weakness of the muscles is a striking feature, those of the surface being flabby and impotent; the sphincters also fail to functionate from this cause, and involuntary evacuations may result. The pupils are dilated, as a rule, and react but slowly to light. Nausea and vomiting may occur, but this is rather a favorable sign, since it is often the precursor of a reaction. Conversely, hiccuph and gastric regurgitation are unfavorable signs. Anuria is frequently noted.

In lethal cases, the mental torpor gradually deepens, syncope comes on, and death follows. This course depicts that observed in great injury involving considerable loss of blood, complicated probably with abdominal or cerebral lesions. Neurotic individuals and drunkards are also exposed to this rapidly fatal form.

In some cases the picture is quite different. Maniacal *furor* seems suddenly to develop, and the patient throws himself or his limbs in every direction, rolls his eyes, strikes right and left, and cries out at the top of his voice. Usually exhaustion soon comes on through recurrence, probably, of hemorrhage on account of the violent exertion.

In cases that proceed favorably, the change for the better is termed the "reaction." All the abnormal symptoms disappear gradually, the return of the muscular tone being manifested by turning, shifting position, etc., while the cardiac symptoms lessen in intensity as the facial color returns. Some cases at this stage go through the maniacal type of shock through unduly rapid resumption of cerebral blood-pressure. In some cases it is a sign of septic infection. The tempera-

ture in a favorable case remains near the normal, though it may exceed this to a marked degree in children without indicating that a complication has occurred. This reaction fever sometimes lasts a couple of days, then gradually disappears.

As regards the differential diagnosis of shock, *internal hemorrhage* is the main source of confusion, since a serious traumatism capable of causing deep shock is capable of causing also some organic injury in some part, local or remote, of the vascular system. This question assumes especial import after an operation owing to the possibility of *concealed hemorrhage*. In the latter case, however, restlessness, tossing, frequently repeated yawning, intense thirst, nausea, impairment of vision due to retinal ischemia, and repeated attacks of syncope are apt to occur. Repeated examinations of the blood will serve to place the differential diagnosis on a surer footing, since hemorrhage produces a gradual diminution of the hemoglobin percentage, while uncomplicated shock does not cause such a change. The cell count, both as to erythrocytes and leucocytes, may, however, indicate a marked decrease, but this is probably due to recession of the blood-mass into the splanchnic area, with resulting ischemia of the superficial vessels. It is, therefore, an unreliable sign. An abdominal hemorrhage may give the physical signs of an increasing accumulation of fluid. While the onset of uncomplicated shock is as a rule sudden, the exhaustion due to hemorrhage is gradual, and finally attended with severe asphyxic phenomena, which are relatively slight in shock.

Delayed shock may come on some hours after an injury or a violent commotion or emotion, such as is witnessed in street-car or railroad accidents. Anesthetics, especially chloroform and ether, may also be followed by shock, not only in the course of but after their use.

Shell Shock.—The European war has shown that shells, mines, and other agents of destruction in which high explosives are employed may, irrespective of or without direct physical injury, give rise to nervous and psychic phenomena which have been variously attributed to "shock," "physical trauma," "concussion

cerebri," etc. In the milder cases, consciousness is not lost, but there may be, for a time, severe pain in the head and spine, incoherent speech, trembling, heaviness of the extremities and temporary anuria. When micturition is re-established, the urine may be found to contain albumin. Uneventful recovery is usual.

In the more severe cases, unconsciousness, lasting an hour or more, is followed by a severe "bursting" headache with some deafness, tinnitus and vertigo, sweating, and tremor, or rhythmic spasmodic movements. Incoherence of speech, mutism, amnesia and various disorders may appear. Catalepsy, followed by convulsions, has also been witnessed. The reflexes are increasingly active, and severe pain with hyperalgesia in various parts of the body, including the appendicular region, may be complained of. The cases usually recover in from one to three weeks. Epilepsy has also appeared in individuals in whom a history of this disease did not exist.

Case of a young man buried in a trench by the explosion of a shell, who was unconscious when rescued. Consciousness was regained in a few hours, but he was totally amnesic so far as his whole life was concerned prior to and including the time of the accident. No efforts to recall his past life were successful, but the practice of **hypnotism** brought out a startling result. While under hypnotic influence he lost his new personality completely and returned to his original one with equal completeness. During this state he was able to recognize his father, remembered all of his past life to the minutest detail, and could even give an accurate account of the accident which caused his mental disturbance. Upon recovery from hypnosis each time he would relapse into his new personality and have no memory of his former one. During the studies made of him in each of his two personalities, it was observed that his voice and his handwriting were different in the two states. In one respect his original personality was retained to a certain extent, namely,

his ability to play a certain musical instrument. Anthony Feiling (*Lancet*, July 10, 1915).

Serious disturbances are produced by wounds of remote localities, and are not necessarily psychogenic. The shock of the wound may cause prolonged unconsciousness from which patient emerges speechless or voiceless. Physical shock must be invoked to explain such cases. A reflex cause could be excluded. The disturbances in question comprised aphasia, phonasthenia, dysarthria including the spastic form, and kinetoses of all kinds, very often accompanied with exhaustive states. Treatment was, for the most part, imperfectly successful with occasional good results. One soldier upon recovering from shock after protracted unconsciousness showed total aphasia. As this passed off dysarthria and dysphasia were left and persisted for eight months. After this bradylalia was the only symptom in evidence. Thirteen months expired before he could resume his duties as officer. Gutzmann (*Berl. klin. Woch.*, Feb. 14, 1916).

This fortunate issue is not, however, the invariable one. In some individuals, after weeks or months, the patients, though apparently recovered, show signs of a changed disposition, manifested especially in abnormal irritability, anxiety, apprehensiveness, or a condition of high emotional state. These may be attended with hallucinations, horrifying dreams, delusions, etc. They lose interest in themselves and in others, become unsocial and morose. The repeated revival of memories of horrible events in the trenches, the death of comrades, shell bursts, blowing up of their trench, etc., serve to sustain the psychic disturbance. The majority of these cases recover, however, but only under well-directed **psychotherapy**, in which sympathy is freely dispensed. Wounds tend to aggravate the trouble, and even to produce it.

The direct effects of the contusion from the air are of extreme variety, as also the various conditions that

may be observed afterward. Sudden death from the shock alone is not rare; immediate unconsciousness is common. It may last for hours or weeks and be followed by total loss of memory for the period since the explosion. The effects of the injury are, in reality, nothing but traumatic hysteria. When the shell explodes near a sleeping person, it does not induce the nervous and mental disturbances otherwise observed. This throws light on the importance of the fright as a factor in the shock. The emotional-neurotic factors are supplemented by the traits for which physical exhaustion is responsible. An exhausted nervous system feels the effect of the explosion more than when fresh or well rested. R. Gaupp (*Beiträge z. klin. Chir.*, Apr., 1915).

From the 156 cases studied, a large majority of so-called shell-shock cases admitted into the hospital with functional neurosis in some form occurred in individuals with a nervous temperament, or with an acquired or inherited neuropathy. In a certain number of cases the cumulative effect of active service had produced a neurasthenic or hysterical condition in a potentially sound individual. Among the large number of officers the writer has seen sent back on account of neurasthenia, none have exhibited symptoms of functional paralysis or mutism. Cases which were supposed to have developed epilepsy as a result of shell shock were, usually, individuals who were either epileptics or potential epileptics prior to the shock. F. W. Mott (*Lancet*, Feb. 26, 1916).

ETIOLOGY AND PATHOLOGY.—

Although the term "shock" is applied to a definite clinical syndrome as a rule, it is often made to cover, pathogenetically, very different conditions: hemorrhage, asphyxia, reflex inhibition, etc. Each of these, however, has its own pathology: cerebral ischemia in hemorrhage; deficient cellular oxidation in asphyxia; vasomotor paresis in reflex inhibition, etc. True shock, however, has a pathology of its

own, changes having been shown to occur in the nerve-cell in keeping with the older teachings based on the histological methods of Golgi, Marchi and Nissl in "shocked" animals. The alterations found by the Golgi method consist in a deformity of the cell-body advancing to the grade of actual atrophy, node-like swellings on the dendrites, and fragmentation of the same. By the Marchi methods there is noted degeneration of various spinal tracts and columns. As observed by the methods of Nissl, the cytological alterations are various, but pronounced. Chromatolysis is present in a large number of cells. Changes in the nucleus,—dislocation or vesiculation,—are also noticeable.

As a result of the central disorder, the vasomotor system becomes more or less incompetent, and reduction of the blood-pressure follows; the peripheral and cerebral vessels are depleted, while the larger trunks within the abdominal cavity are engorged. This may explain the greater danger of a fatal issue when much blood has been lost, the medullary and spinal changes being thus accentuated.

That the adrenals become inadequate from the same morbid action on their governing center—the sympathetic center according to Sajous—seems probable, thus furnishing another causal factor for the low blood-pressure noted. According to Crile the adrenal adynamia resulting from shock is a prominent factor of this condition.

The labors of Elliott and Cannon, Seeley and Lyon have shown that marked epinephrin exhaustion occurs. From the fact that the adrenal ordinarily contains enormous loads to tide the individual through emergencies it would seem that the storage and discharge factors are paramount over the secretory rôles. Further than this, the amounts of epinephrin needed to maintain vasoconstriction that exists in shock are evidence of the continued output of that secretion as long as an available supply exists. The adrenal cortex in shock seems unaffected. J. F. Corbett (*St. Paul Med. Jour.*, xvii, 555, 1915).

Increased quantities of epinephrin are thrown into the blood during con-

ditions of low blood-pressure and shock. The apparent outpouring of epinephrin is not merely a hasty discharge and depletion of the suprarenals; since the quantity of epinephric material in the blood actually increases with the prolongation of low blood-pressure and shock, there must be an active secretion from the glands. The suprarenals seem to function as a line of secondary defence against a falling blood-pressure. The presence of epinephrin in increasing amounts as shock progresses points to an attempt on the part of the circulation to redistribute the blood, bring about peripheral constriction of the arteries wherever possible, and thus maintain normal pressure. Bedford and Jackson (*Proc. Soc. of Exper. Biol. and Med.*, 13, 85, 1916).

The writer defines shock as a gradual progressive fall of blood-pressure due to a paresis or paralysis of the musculature of the arterioles. The only way in which he has been able experimentally to produce anything like shock is removal of the adrenals. Adrenalin produces a good effect in shock not only because it raises the blood-pressure, but because it supplies a something which is essential and in these cases apparently lacking. The treatment of surgical shock consists in continued administration of adrenalin plus efforts to remove the causative factor. J. E. Sweet (*Amer. Jour. Med. Sci.*, May, 1918).

Owing to these organic disturbances, the contractile power of the vessels is lost, the arteries and capillaries becoming depleted through partial transfer of the blood into the deeper venous trunks, those of the splanchnic area in particular. As a result, various organs, especially those farthest from the splanchnic area, the brain, skin, etc., and those of the thoracic cavity are rendered ischemic. Hence the low blood-pressure, the feeble heart action (due in part to deficient adrenal secretion and the resulting deficient contractility of its musculature), the deficient respiratory activity and the profound adynamia observed in shock.

Henderson (1908) has attributed shock to a loss of carbon dioxide through the intermediary of the blood and tissues in the course of operations or severe solutions of continuity. Seelig, Tierney and Rodenbaugh (1916) have sustained this view by using intravenous injections of sodium bicarbonate in shock, the benefit obtained being attributed to the power of this salt to break up in various tissue fluids and thus liberate carbon dioxide.

More recently fat embolism, acidosis, and absorption of toxic products of autolysis of injured tissues have been emphasized as important or essential factors in the production of shock.

Fat embolism emphasized as a cause of shock. An undoubted relation exists between shock and broken bones, particularly when large, as the femur. In 8 experiments on cats, injection of fatty substances into the jugular vein induced a clinical picture essentially similar to traumatic shock in human beings. Fat, often in large quantities, is known to enter the blood vessels in traumatic shock. The injurious effects are due to fat embolism. W. T. Porter (Boston Med. and Surg. Jour., Sept. 6, 1917).

Where there is low blood-pressure in shock, hemorrhage, or gas bacillus infection, there occurs a diminution in the available supply of alkali and hence an acidosis. Operations in shock and acidosis cause rapid fall of blood-pressure and sudden decrease in alkali reserve. Intravenous injection of sodium bicarbonate produces quick relief of acidosis and a rise in the blood-pressure in shocked men after operation. Cannon (Jour. Amer. Med. Assoc., Feb. 23, 1918).

Report of investigations showing the extreme toxicity of crushed muscle tissue, even when aseptic. Absorption of this muscle autolysate is undoubtedly a factor in traumatic shock. Crushed tissues in wounds should be cleared out as an emergency measure at once, without waiting for shock to subside. Delbet (Bull. de l'Acad. de méd., July 2, 1918).

Kinetic Theory.—On the basis of some 1200 experiments, Crile, of Cleveland, was

led to conclude that the key to shock is not in the vasomotor system alone, but in the whole motor mechanism of the body. Those parts of the body having the greatest number of nociceptors—nerve-endings through which defensive reactions are provoked—and which defend the most vitally important structures, are those most active in producing shock on receiving trauma. Thus, the brain, protected as it is by the cranium, is not provided with such nociceptors, does not to any marked extent awaken shock under operation as a rule; the abdominal structures, on the other hand, which are richly provided with nociceptors, readily produce shock when subjected to trauma. Now, the physical basis of Crile's theory is that when, as is the case under the influence of certain anesthetics, ether for example, the reflex motor activity which normally occurs by stimulation of the sensitive nerve-endings fails to occur, and there is no response, the impulses which reach the cortical centers from the peripheral nerve-endings excite and finally exhaust these centers, and produce in them degenerative lesions similar to those that histologists long ago identified as the characteristic cellular lesions of the condition known as shock.

Crile attributes these central morbid changes to "work," i.e., excessive oxidation or febrile process carried on by those organs which alone are capable of transforming latent into kinetic energy, those constituting his "kinetic system," the principal organs of which are the brain, the thyroid, the adrenals, the liver, and the muscles. According to Crile, "the brain is the great central battery which drives the body; the thyroid governs the conditions favoring tissue oxidation; the suprarenals govern immediate oxidation processes; the liver fabricates and stores glycogen; and the muscles are the great converters of latent energy into heat and motion." Yet it is evident that, as Sajous first pointed out in 1903 (when he showed that the adrenal secretion circulated in the brain-cells), it is to the presence in excess of the adrenal principle that the lesions in the nerve-cells are due, for Crile calls attention to the "striking fact" that "adrenalin alone causes hyper-

chromatism, followed by chromatolysis, and in overdosage causes the destruction of some brain-cells."

But it is not only the stress of traumatism or operative procedures on the body which so morbidly affects the nerve-cells of the cortex among others, but also fear, anxiety, the anticipation of a surgical operation, emotional excitement, etc. All these factors added to the surgical traumatism enhance the morbid influence of the latter on the nerve-cell.

How prevent or, at least, reduce these effects, which in the aggregate constitute the condition we term "shock" and which, moreover, reduce the chances of operative recovery? This phase of the question is considered below in the subsection on Prophylaxis, under the title of "anoci-association," a term given by Crile to the measures through which the pathogenic stimuli to the brain may be controlled and at least in a great measure prevented.

PROPHYLAXIS.—The prevention of shock during operations is receiving greater attention as time progresses. Before resorting to any serious surgical procedure the volume of urine excreted in the 24 hours should be ascertained, and an examination of the urine itself made, to ascertain that the kidneys are normal. This is important, since diseases of these organs predispose to shock. The excretion of urea should be ascertained, for if it falls below 2 per cent. metabolism is deficient; such a condition points to asthenia which in turn predisposes to neurasthenic shock. Violent purging predisposes to a similar condition; hence, while freeing the intestinal contents is advisable before operation, it should be done only by means of aperients, or rectal flushing with saline solution. Some surgeons advise the use of morphine hypodermically, $\frac{1}{2}$ grain (0.008 Gm.) given 20 minutes before the operation to quiet the patient, besides the influence of whatever anesthetic is used in that respect; yet others are opposed to opiates in any form. The truth lies between the two extremes; large doses should be avoided.

The manner in which the anesthetic is administered has much to do with the production of shock. To clap a towel saturated with ether on the face of the

already frightened patient and, as far as his own experience is concerned, literally choke him, and have a rough orderly hold his arms and legs to prevent struggling, besides advertising the surgeon and his assistants as tyros, favor the production of precisely the histological changes in the central nervous described above under Pathology as those peculiar to shock. Everything should be done to divest the patient of fear by telling him that he will soon be asleep, perhaps feel a little "stuffy" and the next instant (as regards the patient's own experience is concerned) awake in his own bed. By thus suggesting that he will be subjected to no suffering either through the anesthetic or the operation much can be done to pacify him and otherwise avoid shock. By using the drop method, Allis's inhaler or any other device which insures the patient an ample proportion of air, and avoiding all rough handling, but little if any struggling will occur.

Another important feature is to maintain the surface temperature to its normal level as nearly as possible by covering the parts other than those exposed for operative purposes, with warm blankets and hot-water bottles outside of these (and not in immediate contact with the skin, which may thus be burnt) to sustain the heat. The loss of surface heat when the body is allowed to become cold causes accumulation of the blood in the splanchnic area, an important pathological feature of shock. For the same reason as little blood as possible should be lost and the operation performed as rapidly as safety and thoroughness will warrant.

ANOCI-ASSOCIATION.—We have seen under the heading Kinetic Theory under Pathology, that Crile means by this term a physical exhaustion of the cerebral nerve-cells, brought about by abnormally active stimuli, trauma, pain, fear, emotion, etc. His experiments showed, moreover, that the central lesions produced in the course of surgical operation could be prevented by blocking, as it were, the connection between the traumatized part and the brain-cells by a technique to which he gave the name "anoci-association." Morphine and scopalamine having

been found to conserve the output of energy, thus avoiding the transmission of excessive stimuli to the brain-cells, they form the foundation, as it were, of his method. His technique, as exemplified by its application in abdominal work, is as follows:—

In patients other than infants, the aged, and the asthenic, Crile administers, on an average, $\frac{1}{160}$ gr. (0.01 Gm.) **morphine** and $\frac{1}{160}$ gr. (0.0004 Gm.) **scopolamine** one hour before operation. If local anesthesia alone is employed, **novocaine** in 1:400 solution is used by local infiltration. If inhalation anesthesia is employed, **nitrous oxide** is administered, either alone or with **ether** added as required. As soon as the patient is unconscious, first the skin and then the subcutaneous tissues are infiltrated with 1:400 **novocaine**. The **novocaine** is spread by immediate local pressure with the hand. Incision through this anesthetized zone exposes the fascia, which is novocainized, subjected to pressure, and then divided. In succession also the remaining muscles or posterior sheath and the peritoneum are infiltrated with **novocaine**, subjected to pressure, and divided within the blocked zone. If the blocking has been complete, then within the opened abdomen there will be no increased intra-abdominal pressure, no tendency to expulsion of the intestines, and no muscular rigidity.

The peritoneum is next everted and infiltrated with a 2½ per cent. solution of **quinine and urea hydrochloride**, so that the line of proposed suture is completely surrounded. As before, momentary pressure serves to spread the anesthetic. This infiltration of quinine and urea hydrochloride serves as a block which may last for several days. It prevents or minimizes postoperative shock. It causes a certain amount of edema of tissue which lasts for some time after the wound is healed.

With this technique the relaxed abdominal wall permits the easy and gentle exploration of the entire abdominal cavity. If there is no cancer in the field of operation and if no acute infection is present, then the following regions may be blocked as completely and in the same manner as the abdominal wall—namely, the meso-appendix, the base of the gall-bladder, the

uterus, the broad and the round ligaments, the mesentery, and any part of the peritoneum. Since operations on the stomach and intestines cause no pain if they are made without pulling on their attachments, no **novocaine** block is required in such operations.

In operations carried out in this manner the closure of the upper abdomen is as easy as the closure of the lower; all is done with ease in perfect relaxation. No matter how extensive the operation, how weak the patient, or what part is involved, if the technique is perfectly carried out, the pulse rate at the end of the operation is the same as at the beginning. The postoperative rise of temperature, the acceleration of the pulse, the pain, the nausea, and the distention are minimized or wholly prevented according to Crile.

The cause of the high mortality of operations on the gall-bladder is exhaustion and shock, the exhaustion of the vital organs of the body. In excision of the liver and adrenals within a few hours the blood becomes acid. In every case of exhaustion the same changes were found in the brain, liver, and the adrenals. Postoperative pain finally overcomes the margin of safety and the patient dies. Neutralization of the acids is one of the most important functions of the liver. Every response to stimuli produces an acid condition. The margin of safety is reduced in exhausted patients by this acidosis. An increased acidity always accompanies inhalation anesthesia. Ether, however, adds another strain. The liver finally becomes no longer able to neutralize the acidity. The only cure for the acidosis is prevention, which may be largely accomplished by increasing the store of energy and preventing the waste of it. **Glucose and bicarbonate of soda** and **sleeping in the open air** will increase the store of energy. **Morphine** does not increase the acidity of the blood, but if the latter is once produced by emotion, starvation, or whatever cause, large doses of **morphine** will then rob the body of its power to neutralize the

acidosis. But if given before the acidosis occurs, the morphine will not have any effect. Psychic rest is obtained by twilight anesthesia. If the margin of safety is very narrow the operation should be done in two stages. Avoidance of injury to the splanchnic nerves is insisted upon. Crile (*N. Y. Med. Jour.*, July 4, 1914).

As a preliminary narcotic a combination of *omnupon* and *scopolamine* is recommended. It is also valuable to give a dose of *veronal* on the evening preceding the operation. The writer's method of producing local anesthesia for abdominal operations is essentially the anesthetization of the several nerve-trunks laterally upon the abdomen through 5 or 6 punctures. The solution consists of 0.4 Gm. ($6\frac{1}{2}$ grains) of *potassium sulphate* and 12 drops of synthetic *adrenalin* to each 100 c.c. of $\frac{1}{4}$ per cent. solution of *novocaine*. All the tissues, from the skin to the peritoneum, should be infiltrated at the site of each puncture. In addition to this the line of incision is infiltrated in a similar manner, and, if necessary, additional infiltration of the mesenteric attachments, etc., may be made. With his technique the writer had only 2 cases of post-operative shock in well over 2000 cases. H. M. W. Gray (*Brit. Med. Jour.*, Aug. 22, 1914).

To illustrate the value of anoci-association, the writer offers a table of all hysterectomies operated on since the adoption of the necessary technique. Excluding 2 legitimate exceptions, the average pulse rate for 17 hysterectomies the evening before operation was 89; the average pulse rate the evening after was 80. Some of these patients were very much exsanguinated by prolonged hemorrhages and some had large tumors. The value of the method seems incontestable. J. M. Wainwright (*Penn. Med. Jour.*, Dec., 1914).

The writer advises that glucose solution be given at a routine after every operation in which one has reason to fear more than the ordi-

nary amount of postanesthetic shock; it should be given as a routine in every case in which postoperative oral feeding may be difficult or insufficient for a considerable period after operation; it should be given as an emergency measure either before or after operation for the relief of an existing or threatened acidosis. Burnham (*Amer. Jour. Med. Sci.*, Sept., 1915).

TREATMENT.—Raising the limbs and body in such a way as to cause the blood to gravitate toward the head, followed by absolute rest and quiet in the recumbent position, and the external application of heat (taking care that the skin be protected by the blanket or that the water-bottles or bags used be wrapped in cloths or flannel, lest they burn the patient) around the trunk and extremities, are the first measures to be resorted to.

Having treated 6667 wound cases, the writer divides shock cases into 3 major groups, viz., nervous, hemorrhagic, and toxic. A group apart is that by exposure or exhaustion. Of 103 cases of hemorrhagic shock operated upon at once, 96 recovered, tending to show the advisability of immediate operative hemostasis in hemorrhage cases, whether shock is or is not present at the same time. Under nervous shock are placed concussion, multiple wounds, or extensive contusions. In these, the system has reached the extreme limit of its resisting powers and treatment is often disappointing. In 4 cases of grave nervous shock, however, expectant treatment and postponement of operation were followed by recovery. In toxic shock from absorption, an opportunity for recovery is afforded only by prompt removal of the toxic tissues. Of 13 cases thus treated, all recovered. Gatellier (*Presse méd.*, Jan. 17, 1918).

Adrenalin has to a considerable extent replaced all other stimulants when injected in conjunction with saline solution into the arterial system—for rapid action—or into the veins. Its effect may, however, be transient. Two important measures developed and found serviceable

during the late war were, intravenous injection of 6 per cent. gum acacia solution to cause a persistent rise in the blood-pressure, and the removal of lacerated or crushed tissues to obviate shock from toxic absorption.

Locke's solution plus 3 per cent. of gum acacia used with success in the treatment of low blood-pressure from hemorrhage and shock. If there has been great loss of blood, the Locke must be preceded by an infusion of normal saline or sugar solution to give the heart fluid to pump on, the mucilaginous Locke solution not being given in amounts exceeding 150 c.c. (5 ounces). Delaunay (Lyon chir., Jan.-Feb., 1918).

In shock the catalase of the blood and probably of the tissues is decreased, owing to diminished output of it from the liver and probably to dilution of the blood. Alcohol in shock greatly increases the catalase of the blood and tissues by stimulating the liver to increased output. The beneficial effect of alcohol in shock and general depression is due to the increase it causes in the catalase of the blood and tissues, with resulting increase in oxidation and decrease in acidosis. Burge and Neill (Amer. Jour. of Physiol., Feb., 1918).

Shocked patients should be placed in the quietest available quarters, kept darkened, with comfortable beds. The bed may be warmed with a cradle heated by electricity or an alcohol lamp. The arterial pressure should be taken every hour. Morphine is given regularly as it seems effective in raising the blood-pressure. Subcutaneous injections of saline solution with adrenalin complete the treatment, and the patient sleeps. When the blood-pressure has improved to 40 and 70 or 80 mm. Hg, then operation is to be considered. Necessity for local as well as general anesthesia emphasized. Montéry and Lombard (Arch. de méd. et de pharm. milit., Mar., 1918).

Primary shock tends to lessen hemorrhage, and if the patient is kept warm and quiet, the blood-pres-

sure may return to normal. Partial recovery, however, may be followed by secondary shock. The best explanation of this is an accumulation and stasis of blood in the capillaries—Cannon's *exemia*. As a result the tissues suffer from oxygen starvation and the vasomotor and respiratory centers tend to fail. Acidosis is not a serious factor in shock. It has not yet been demonstrated that the symptoms relieved by sodium bicarbonate would not be more definitely cured by raising the blood-pressure. The main factor in treatment is to ensure an adequate supply of blood to vital organs. A solution of gum arabic (acacia) injected intravenously in most cases is not inferior to blood. A 6 per cent. solution of the gum is best, with 0.9 per cent. of common salt. This maintains the blood-pressure indefinitely. Its value is most strikingly demonstrated after hemorrhage, though after grave hemorrhage blood transfusion is the procedure of choice. W. M. Bayliss (Brit. Med. Jour., May 18, 1918).

Traumatic or wound shock is due to toxic material from injured tissues. If the blood-pressure falls below 80 mm. Hg, the tissues begin to suffer from lack of oxygen. In the treatment, arterial pressure should be raised by blood transfusion if it persists below this critical level. Crushed tissue should be removed as soon as possible. If a limb is shattered and useless, absorption of toxic material may be prevented by a tourniquet. Amputation should be done proximate to the tourniquet and before removing it. Loss of body heat should be checked and normal temperature restored by application of heat. Since ether lowers the blood-pressure in shock, it should be avoided. Nitrous oxide and oxygen should be used in a ratio not exceeding 3 to 1, preceded by morphine. Deep anesthesia and cyanosis should always be avoided. W. B. Cannon (Proceedings Amer. Med. Assoc., N. Y. Med. Jour., June 14, 1919).

Crile's technique for the resuscitation

of a patient is as follows: The patient, in the prone position, is subjected to rapid rhythmic pressure upon the chest, with one hand on each side of the sternum, to produce artificial respiration and promote circulatory activity. A cannula being then inserted into an artery, toward the heart, normal saline solution (2 teaspoonfuls of sodium chloride—being careful not to use the non-deliqescent table salt now commonly employed—to the quart of warm water) is infused through a funnel connected with the rubber tubing connected with the cannula. As soon as the flow has begun, 15 to 30 minims (0.9 to 1.8 c.c.) of **adrenalin chloride** (1:1000) are injected at once with a hypodermic syringe plunged into the rubber tubing, i.e., into the saline solution, repeating the dose in a minute if needed. The rhythmic pressure on the thorax being exerted with maximum activity, plus the powerful contraction of the arteries, including the coronaries, caused by the infusion, promptly provokes a powerful rise of blood-pressure. When this attains about 40 mm. the heart resumes its action, its contractions steadily increasing in vigor. As soon as the cardiac beats are fairly resumed, the cannula should be withdrawn; otherwise the marked increase of vascular tension will drive a torrent of blood into the tube. **Pituitary extract** in 1:10,000 solution seems to sustain the effect on heart and circulation longer than adrenalin.

An important feature of **arterial or venous infusion** is that it should not be given rapidly; otherwise an excessive amount of fluid will suddenly accumulate in the right ventricle, and the heart, already feeble, will cease altogether to pulsate.

In prolonged shock, **high enteroclysis** or **hypodermoclysis** of saline solution is indicated. Dawbarn urged that, whenever possible, the solution should be introduced into the median basilic vein, but occasionally a vein in the operating wound will answer the purpose, or, if necessary, the solution may be introduced into the common femoral artery with the aid of an hypodermic needle attached to a fountain syringe. Next in order of efficiency to intravenous saline infusions are those

introduced into the rectum. **Hypodermoclysis** is the slowest of all the methods. The proper temperature for the solution according to Dawbarn is about 150° F., but this seems high. At least 1 quart, and sometimes even 2 or 3 quarts, may be injected, providing the precaution is taken to introduce the solution *slowly*. The time occupied in introducing the fluid should never be less than ten minutes per quart. The employment of intravenous injections before or at the beginning of the operation is not good practice, since, by increasing the blood-pressure, it encourages free hemorrhage.

Valuable for intravenous infusions in shock is **Ringer's solution**, prepared as follows:—

Calcium chloride... 1½ gr. (0.1 Gm.).
Potassium chloride. 1 gr. (0.06 Gm.).
Sodium chloride... 90 gr. (6.0 Gm.).
Water 1 qt. (1000 c.c.).

M.

Careful asepsis of the arm, apparatus, and solution is important; also the exclusion of all air from the tube before introducing the cannula. The solution should be free from solid particles. A probe-pointed cannula should always be used. The temperature of the solution should be about 100° F.; hotter solutions are of greater value as a stimulant; an initial temperature of 108° to 110° F. is well borne. The fluid is cooled from one to two degrees by entering the cannula. The amount of the solution to be injected at one time varies with the rapidity of the injection and with the quality and tension of the pulse; 1 quart, repeated when necessary, is generally better than a large amount given at one time. It is of greatest value in shock accompanied by hemorrhage. In threatening cases of this class **direct blood-transfusion** should be resorted to.

As regards medical treatment, Senn recommended the inhalation of nitrite of amyl, and the administration of stimulants, such as alcohol, hot coffee, and tea. Of alcoholic stimulants, hot red wine, rum, and brandy-punch deserve the preference. Alcohol in small doses tends to raise the blood-pressure by promoting oxidation and therefore metabolism in the muscular layer of the arteries.

Opium is contraindicated in the treatment of uncomplicated shock, but **atropine** is recommended by J. C. Da Costa, particularly when the skin is very moist.

Subcutaneous injections of **sterilized camphorated oil** is a valuable cardiac stimulant, 3 or 4 hypodermic syringefuls being administered every fifteen minutes until reaction sets in. **Digitalis** may be used, but it acts slowly in an emergency. **Strophanthin**, using the 1 c.c. (16 minims) of the 1:1000 solution in sterile ampoules is far more effective. It should be remembered that in shock the absorption of all drugs administered by the stomach or rectum, or even injected into the tissues, is always slow; hence, care is necessary to guard against cumulative action during the recovery of the patient.

Research showing that **epinephrin** has no cumulative action. Its action occurs only on direct contact. The continual infusion of a weak solution of **epinephrin** may prove a useful measure in therapeutics. It is thus possible to send the solution continuously into a vein and thus keep up the blood-pressure permanently while this is being done—the effect being dependent on the concentration of the solution, not on the absolute amount of **epinephrin** infused. Straub (Münch. med. Woch., June 27, 1911).

Adjuvant measures, such as the **inhalation of oxygen**, **mustard plasters** over the heart, the spine and shins; an **enema of turpentine**, **hot coffee**, **whisky** or **brandy**; **Esmarch bandages** around the legs and arms or a **tight abdominal binder** to drive the blood toward the vital organs and increase the general blood-pressure, are all helpful. Crile deems an increase of peripheral vascular resistance advantageous and places his patient in an air-tight rubber suit which he inflates with an air pump, thus insuring equable pressure upon the entire cutaneous surface. **Abdominal massage** to favor the better distribution of blood from deeper vessels, followed by the application of the abdominal binder referred to above, has been lauded as an efficient measure. **Galvanism of the phrenic** has been used to promote contraction of the diaphragm and therefore excite respiratory activity.

ELECTRICAL SHOCK.—The two main causes of death from shock due to electrical currents, as stated by Spitzka, Stanton and Krida and others are cardiac fibrillation and respiratory paralysis. The cessation of respiration is a secondary phenomenon, however, though usually simultaneous with cardiac arrest. Commercial low-tension currents tend to kill chiefly by producing cardiac fibrillation. As the tension is increased the effect upon the heart becomes less pronounced, but at the same time the effect upon the central nervous system becomes more and more certain as the tension is increased; so that with high-tension currents death is more likely to be caused by respiratory failure, although if the contact is prolonged the heart is also stopped. All evidence points to the central nervous system as being the chief sufferer from the effects of currents of more than 4800 volts.

Treatment.—Even in cases of good contact, as with a high-tension current, according to Spitzka, there may be no heart paralysis, but only respiratory failure, and in such cases respiration may be re-established spontaneously or artificially. The prognosis is good only in cases in which there is some heart action and respiration, the former, particularly.

The stricken individual must, of course, be taken out of the circuit, if he be not already freed from it. Bystanders can do this with rubber gloves, or with hands wrapped with thick, dry, woolen material, by pulling at the victim's clothing, by sticks of wood, or, if in contact with a wire, this may be cut with a nipper with insulated handles. This must be done with caution, as the momentary arc formed between the separated ends may blind the rescuers.

The patient should be laid with the head a little higher than the body, and **artificial respiration** be begun promptly by compressing the thorax about 18 times a minute, with the hands applied flat to the sides and lower part of the chest. The tongue must be drawn forward, or the **pulmotor** may be used if available. **Massage over the heart**, **faradization**, the electrodes applied to the neck and heart region, or **adrenalin injection** by Crile's

method, may be used to stimulate heart action. The epiglottis may be tickled with the forefinger. Other methods that have been suggested are lumbar puncture, venesection, the application of the Leduc current, and, in the last resort, a high-tension shock of short duration. S.

SILVER.—Silver (argentum) in its pure metallic state has a white color and a high degree of luster. It is unaffected by oxygen or moisture, but is readily attacked by sulphur, and tarnishes when exposed to air containing hydrogen sulphide. The metal itself is not official, but is used at times in a colloid state in unofficial preparations. Of its salts, the nitrate is most largely used.

PREPARATIONS AND DOSE.

—*Argenti nitras*, U. S. P. (silver nitrate) $[\text{AgNO}_3]$, occurring in colorless, rhombic plates, with a bitter, caustic, metallic taste. It is soluble in 0.54 part of water, and in 24 parts of alcohol. It melts at 200°C . It is rapidly reduced by organic matter in the presence of light, becoming gray or grayish black. Dose, $\frac{1}{8}$ to $\frac{1}{2}$ grain (0.007 to 0.03 Gm.).

Argenti nitras fusus, U. S. P. (molded silver nitrate, lunar caustic), prepared by melting silver nitrate with $\frac{1}{25}$ its weight of official hydrochloric acid, stirring, and pouring into suitable molds. It occurs as a white, hard solid, usually in cones or pencils, with a caustic taste, and becomes grayish on exposure to light and organic matter. It is incompletely soluble in water and in alcohol, the contained 5 per cent. of silver chloride remaining undissolved. Used externally.

Argenti nitras mitigatus, U. S. P. VIII (mitigated silver nitrate; mitigated lunar caustic), prepared by melting

silver nitrate with 2 parts of potassium nitrate, stirring and pouring into molds. It occurs as a white, hard solid, with properties similar to those of the preceding preparation. It is soluble in water, but the contained 66.7 per cent. of potassium nitrate is only sparingly soluble in alcohol. Used externally.

Argenti oxidum, U. S. P. (silver oxide) $[\text{Ag}_2\text{O}]$, occurring as a heavy, brownish-black powder, with a metallic taste. It is liable to reduction on exposure to light. It is very slightly soluble in water, to which it imparts an alkaline reaction, and is insoluble in alcohol. Dose, $\frac{1}{2}$ to 2 grains (0.03 to 0.13 Gm.); average, 1 grain (0.065 Gm.).

Argenti cyanidum, U. S. P. VIII (silver cyanide) $[\text{AgCN}]$, occurring as a white, odorless and tasteless powder, gradually turning brown on exposure to light, insoluble in water and in alcohol. Formerly used in the preparation of diluted hydrocyanic acid.

Among the unofficial preparations of silver are the following:—

Silver citrate $[\text{Ag}_3\text{C}_6\text{H}_5\text{O}_7]$, occurring as a white, heavy powder, soluble in 3800 parts of water, and sensitive to light. It is considered non-irritating, and has been applied in substance as antiseptic to wounds and ulcers, and injected in solutions of 1:4000 to 1:10,000 strength into the urethra, etc.

Silver lactate $[\text{AgC}_3\text{H}_5\text{O}_3 + \text{H}_2\text{O}]$, occurring in crystalline needles, soluble in 15 parts of water, and turning brown on exposure to light. Used externally (though irritating) for its powerful antiseptic effect in 1:100 to 1:2000 solutions.

Albargin (gelatose silver). See ALBARGIN in the second volume.

Argentamin (ethylene-diamine silver nitrate), a solution of 1 part each of silver nitrate and ethylene-diamine [$\text{CH}_2(\text{NH}_2)\text{CH}_2(\text{NH}_2)$] in parts of water. A colorless, alkaline fluid, turning yellow on exposure to light. Asserted to be non-irritant and more penetrating than silver nitrate, owing to the albumin-solvent action of the containing ethylene-diamine. Used in the urethra in 0.25 to 4 per cent. solution, and in ophthalmology in 5 per cent. solution.

Argonin (silver casein), prepared by precipitating an alkaline solution of casein with silver nitrate and alcohol. A fine, nearly white powder, containing 4.28 per cent. of silver, easily soluble in water, forming an opalescent solution which clears on addition of sodium chloride. Used as silver nitrate, generally in 0.5 per cent. solution.

Argyrol (silver vitellin), said to be prepared by electrolysis of serum albumin, addition of moist silver oxide, heating the mixture under pressure, and drying *in vacuo*. It is probably a compound of hydrolyzed protein and silver oxide, and contains from 20 to 25 per cent. of silver. It occurs in black, shining, hygroscopic scales, freely soluble in water and glycerin, but insoluble in alcohol and oils. It is not affected by boiling. It is incompatible with acids, and most neutral or acid salts in strong solution. Used as a non-irritant antiseptic in 5 to 25 per cent. solutions in urethritis, cystitis, and diseases of the mucous membranes of the eye, ear, nose, and throat.

Hegonon (silver nitrate ammonia albumose), obtained by treating silver ammonium nitrate with albumose. A light-brown powder, readily solu-

ble in water, said to contain about 7 per cent. of organically combined silver. Used as substitute for silver nitrate for irrigation purposes in 1:2000 to 1:6000 solutions.

Ichthargan (silver ichthyolate or ichthyosulphonate), prepared by neutralization of ichthyosulphonic acid with silver oxide, and extraction with water. A brown, stable powder, with a light chocolate-like odor, asserted to contain 30 per cent. of metallic silver and 15 per cent. of sulphur in organic combination, freely soluble in water, but incompatible with soluble chlorides. It is said to combine the bactericidal action of silver with the penetrating, antiphlogistic action of ichthyol. Used in 0.04 to 0.2 per cent. solution in gonorrhea; 3 per cent. solution in posterior urethritis, and in 0.5 to 3 per cent. solution in trachoma.

Protargol (protein silver salt), prepared by treating proteins with a silver salt, and rendered soluble by treatment with a solution of albumoses. A light-brown powder, containing 8.3 per cent. of silver in organic combination, soluble in 2 parts of water. The solution is not affected by alkalis, chlorides, bromides, or iodides, nor by heat. Its precipitation by cocaine hydrochloride is prevented by addition of boric acid. It should not be exposed to light. Used as substitute for silver nitrate for irrigation purposes in 1:1000 to 1:2000 solutions, in 0.25 to 1 per cent. solutions in acute gonorrhea, and in 5 to 10 per cent. instillations in chronic gonorrhea, and in diseases of the mucous membranes of the eye, ear, nose, and throat.

Colloid silver and its action and therapeutic uses have been discussed

under the heading COLLARGOL, in the third volume, to which the reader is referred.

INCOMPATIBILITIES.—Silver nitrate is incompatible with organic material, becoming transformed into the black oxide of silver or black metallic silver. With soluble chlorides or hydrochloric acid it forms the insoluble silver chloride. It is also incompatible with bromides and iodides, with alkalies, with acetates, chromates, cyanides, hypophosphites, phosphates, sulphides, sulphates, and tartrates, with copper salts and ferrous and manganous salts, with antimony salts and arsenites, with morphine salts, with alcohol, with creosote, with oils, and with tannic acid and vegetable astringent preparations.

MODES OF ADMINISTRATION.—Silver nitrate, when used internally, is generally given in pills, but may also be administered in a solution of 0.2 per cent. strength, preferably through a stomach-tube to avoid precipitation of the silver before it reaches the gastric cavity. When thus given, it should soon after be removed by lavage. Silver nitrate pills should be made with kaolin or petrolatum, as glucose, glycerin, extracts and other materials commonly used as excipients render the salt inert. The following formula for silver-nitrate pills has been recommended:—

℞ *Argenti nitratis* gr. 1½ (0.1 Gm.).
Sodii sulphatis ex-
siccati gr. viij (0.5 Gm.).
Kaolini gr. xv (1 Gm.).
Aque destillata gtt. x.

Fac. in pilulas no. xx.

(Each pill contains ½ grain—4.005 Gm.—of the silver salt).

Where silver nitrate is to be used locally at intervals in the form of a solution, addition of spirit of nitrous ether is considered of value in preventing precipitation. The following formula is credited to Fox and Higginbotham:—

℞ *Argenti nitratis* gr. v (0.3 Gm.).
Spiritus ætheris nitrosi f3ij (8 c.c.).
Aque destillata f3vj (24 c.c.).

M.

Such a solution may be applied freely to the conjunctiva, without neutralization with salt solution, in all forms of conjunctivitis, from a mild “pink eye” to gonococcal conjunctivitis (Valk).

Where it is desired to use an ointment of silver nitrate, the following combination may, with advantage, be employed:—

℞ *Argenti nitratis* gr. xv (1 Gm.).
Acidi borici pulveris.. ℥iiss (10 Gm.).
Cera flava ℥j (30 Gm.).
Olei olivæ ℥ij (60 Gm.).

M.

Silver oxide is generally administered in pill form.

The “organic” silver compounds, such as protargol and argyrol, are used externally, generally in solution. (See below, under Therapeutics.)

PHYSIOLOGICAL ACTION.—

Locally, silver nitrate is antiseptic and very irritating. It is astringent, coagulating proteins, and also caustic, readily destroying soft tissues with which it is brought in immediate contact in concentrated form. It coats moist tissues with a tough, white film, and has not much penetrating power, though Wildbolz found 1:1000 to 1:100 solutions to penetrate to the subepithelial tissue in the urethra of the dog. In dilute solution it overcomes relaxation of

tissues, and apparently improves local nutrition. Its local action, if excessive, can be quickly arrested with a solution of sodium chloride, which precipitates it as silver chloride. Applied to the skin, it produces a brown and, later, a black stain, on exposure to light.

The "organic" preparations of silver, such as argyrol and protargol, are not precipitated by protein and sodium chloride, and are not astringent. Protargol is but slightly irritant, as compared to silver nitrate, and argyrol hardly irritant at all. Their efficiency as antiseptics is, however, far less than that of silver nitrate, for which, in spite of their low irritant power, they are not, therefore, adequate substitutes where a strong antiseptic action is desired. Post and Nicoll found the gonococcus killed in one minute by 1:5000 silver nitrate, but only partially inhibited in the same period by 10 per cent. protargol, and hardly at all influenced by 10 per cent. argyrol. Similar results were obtained in the case of the pyogenic streptococcus and the pneumococcus, except that a 1:1000 silver-nitrate solution was required to kill these organisms in one minute. The typhoid organism, on the other hand, was killed in one minute only by a 1 per cent. silver-nitrate solution, though succumbing completely in the same period to 10 per cent. argyrol or protargol. The antiseptic action of silver nitrate is due, not only to coagulation of the protein of the bacteria, but also to a specific action of the metal, silver proteinate itself being antiseptic.

The bluish-white pellicle which follows the application of silver nitrate to the conjunctiva is not coagulated

albumin, but chloride of silver deposited in the structure of the membrane. The essential element in determining the stain is the soluble chlorides of the tissues. It is chloride of silver that is decomposed by light, not albuminous material. The brown stain is either argentous chloride or an oxychloride of silver. Drops of silver-nitrate solution are more potent in causing a stain than an application of a stronger solution by the brush.

The penetration of a 20 per cent. solution of argyrol as compared with weak silver nitrate is practically nil. The amount of silver organic silver compounds contain is no criterion of their therapeutic utility. Argyrol may have a mechanical effect, and its sedative action is due to the large amount of silver it contains, metallic silver being sedative in its action. Burden-Cooper (Ophthalmoscope, Jan., 1907).

Silver acetate forms a durable solution and has the least irritating action on the tissues of all the silver salts. It is strongly bactericidal. It is important to follow its application by rinsing with water or with a weak salt solution. Schweitzer (Archiv f. Gynäk., Bd. xcvii, nu. 1, 1912).

Silver nitrate dissolved in water killed the dysentery bacillus in five minutes. On the other hand, in broth, with the addition of a little organic matter and salts, it failed in a strength of 1 in 100. The frequent failure of silver-nitrate injections in dysentery is thus easily understood. Albargin gave the best results of any of the silver compounds in the presence of broth, as it killed the dysentery bacillus within five minutes in a dilution of 1 in 500, but it was less efficient in a second trial. Collargol, ichthargan, and argyrol had little or no action in the presence of broth. Rogers (Indian Jour. of Med. Research, Oct., 1913).

General Effects.—Taken internally in moderate dosage, silver nitrate has

been held to act as a tonic to the nervous system, exert a favorable influence on the blood, and promote constructive tissue metabolism, but there exists no definite pharmacologic evidence supporting these views. Administered subcutaneously or intravenously in poisonous doses in animals, its characteristic effects appear to be primary stimulation of the central nervous system, especially the medullary centers, followed by depression and paralysis; in slower poisoning, a marked increase of bronchial secretion, ending in edema of the lungs, has been observed. In cold-blooded animals, silver salts are said to give rise to convulsions in some ways similar to those of strychnine, followed by paralysis. These effects have no evident therapeutic bearing. Large amounts of silver nitrate taken internally produce, by reason of their caustic action, a violent gastroenteritis, thrombosis of the gastric veins, and ulceration of the gastric mucosa.

Absorption and Elimination.—It is believed that in man the greater part of the silver ingested passes through the alimentary tract unabsorbed. The remainder is apparently absorbed in the form of a solution—none of it being found in the gastric or intestinal epithelia—and is soon after deposited in the tissues in minute granules, believed to consist of an organic compound of silver. That it stays imbedded thus indefinitely is suggested by the fact that the resulting pigmentation remains unaltered over long periods.

Frascchetti and others deny that any elimination of silver takes place in man, either through the kidneys or the intestines.

POISONING.—There are two forms of poisoning by silver—that following a large single dose (acute), and that following the long-continued use of small doses (chronic).

Acute Poisoning.—The symptoms of acute poisoning by silver nitrate are partly gastrointestinal and partly cerebrospinal. Either series of phenomena may predominate.

Almost immediately after a poisonous dose, a burning is felt in the throat and stomach, and soon after violent abdominal pain, with vomiting and purging, comes on. The abdominal walls may become hard and knotted, more rarely scaphoid. The face becomes flushed or livid, and is covered with sweat. The expression is one of anxiety. When vomiting occurs, the ejecta are often brown or blackish in color, though sometimes white and curdy, especially after sodium chloride has been given. The lips and mouth are covered with a grayish-white membrane, which may later change to brown and then black. Occasionally, where the poison has been ingested in solid form, this membrane is absent.

In some cases the nervous symptoms are severe, consisting of incoordination, paralysis, and convulsions with coma or delirium. The convulsions are generally tetanic, persist, according to Rouget, after complete abolition of voluntary movements, and, according to Curci, are due to excitation of the motor cells of the cord.

Collapse follows, because of the gastrointestinal corrosion produced, and death takes place from asphyxia due to central respiratory paralysis, accompanied by a profuse flow of bronchial secretions, causing pul-

monary edema. In a case reported by Beck coma returned at intervals during several days before the patient died.

At *post mortem* the stomach and bowels are found corroded, often ecchymosed, and with patches of a white or grayish color. The lungs are congested and the bronchial tubes filled with fluid.

Poisoning by this drug is not common. The lethal dose is not certain; 30 grains have killed and recovery has followed the ingestion of an ounce.

Treatment of Acute Poisoning.—The chemical antidote is common salt (sodium chloride), which should be administered in large amounts. Vomiting should then be induced at once, as the silver chloride formed is soluble in solutions of sodium chloride and in the digestive fluids. **Lavage of the stomach** with a very soft stomach-tube may be carefully tried. If the stomach cannot be washed out, one may give large draughts of salt-water and produce vomiting alternately. **Opium** and **oils** may be given to allay the irritation, and large draughts of **milk** administered to dilute the poison and protect the mucous membranes. **Mucilaginous fluids** and **white of egg** may also be used as demulcents. **External heat** should be applied if indicated, and in the event of collapse, the customary **stimulant measures** availed of, together with **artificial respiration**. **Atropine** might prove of value to counteract the excessive bronchial secretion.

Chronic Poisoning.—Prolonged internal use of any of the soluble salts of silver gives rise to chronic poisoning, or **argyria**. A local argyria, or

argyrosia, may be caused by the frequent topical application of a soluble silver salt for a prolonged period. Discoloration of the eyelids, conjunctiva, and cornea has been observed from the use of silver nitrate in the eye, and a similar condition noted from its local application in the throat, or a blackening of the hands from constant working with silver. A few cases have even been reported of general argyria resulting from topical use of silver in the mouth and throat.

General argyria was formerly more frequent than now, arising frequently from the administration of silver nitrate in epilepsy. The first sign of it is the appearance of a slate-colored line along the gums, associated with some inflammatory swelling. Later grayish spots or patches appear on the skin and mucous membranes, and spread over the whole body until the skin has acquired a peculiar bluish-slate color, which may become very dark. In decided cases, the conjunctivæ and oral mucous membrane are involved. In some cases discoloration is especially marked in the face. The silver is found in all the tissues of the skin below the rete Malpighii, and is deposited mainly in the connective tissues, the various parenchymatous cells, and epithelia of the body escaping the pigmentation. Although the discoloration is long in making its appearance, the deposition in the tissues probably begins at once, gradual accumulation thereafter taking place. Especially marked deposition occurs in the renal glomeruli, the hepatic and splenic connective tissue, the mesenteric glands, the serous membranes, and the choroid plexus. The connective

tissues throughout the respiratory passages and alimentary canal likewise show silver deposition. The condition of argyria does not seem to affect the general health.

Two women were workers in silver leaf, their task being to cut the leaves and lay them in books. One, aged 27, had worked steadily for fourteen years. The discoloration of the skin was first noted when she was 18, and it increased steadily for four years, then remained the same. It affected chiefly the exposed parts and visible mucosæ. The other patient, 50 years old, had begun to follow the occupation at 14, and had first noticed the discoloration at 21. Both women exhibited anemia and disordered digestion several years before the appearance of the argyrosis. The silver line on the gums should be watched for as a danger signal in subjects similarly occupied. Koelsch (Münch. med. Woch., Jan. 30, Feb. 6, 13, 1912).

Argyria has been induced in three months, and after the use of $\frac{1}{2}$ to 1 ounce (15 to 30 Gm.) of silver nitrate (Cushny).

Treatment of Chronic Poisoning.—

Prophylaxis is important. When the salts of silver are indicated in a prolonged course of treatment, occasional discontinuance of the remedy is imperative. At the end of the third week, the remedy should be stopped for one week, and after three months a long intermission should follow. In the intermissions of treatment, the patient should receive a thorough course of purgatives, diuretics, and baths. Potassium iodide may be given with the silver salts to expedite its elimination.

Greater or less success has been claimed for various treatments in argyria, but in general they are futile. Rogers claims that blistering will lighten the color, but how it should

do so is not plain, since the silver deposit lies deep down in the skin. Eichmann recommends the use of potash baths and of soap baths, each four times a week. The internal use of potassium iodide may produce some change in the color of the skin, but perfect restoration to the normal is generally unattainable.

Report of the case of a young woman, supposedly suffering from jaundice, which turned out to be argyria following a course of colargol. A dose of 10 grains (0.65 Gm.) of hexamethylenamine, given for a coryza, caused marked improvement in the patient's coloration. A. M. Crispin (Jour. Amer. Med. Assoc., May 2, 1914).

THERAPEUTICS. — Gastrointestinal Disorders.—Silver nitrate has been found of some value in the treatment of gastric ulcer. It is often given in pill form, sometimes in combination with extract of hyoscyamus or opium. As hydrochloric acid or sodium chloride renders it inert by precipitation of silver chloride, it may prove useless unless its ingestion is preceded by lavage of the stomach. A 1 in 500 solution of it may then be introduced through the tube to the amount of $\frac{1}{2}$ fluidounce (15 c.c.), and in a few minutes lavage with plain water repeated. The dose of silver nitrate in pill form in these cases is $\frac{1}{4}$ to $\frac{1}{2}$ grain (0.015 to 0.03 Gm.). If it is given in solution, sodium bicarbonate may, with advantage, be added.

Pyrosis is frequently relieved by 1-grain (0.065 Gm.) doses of silver oxide, given in pill form, a half-hour before meals.

In chronic gastritis and gastric catarrh, when sour eructations or vomiting occur after meals, the ni-

trate in doses of $\frac{1}{8}$ to $\frac{1}{4}$ grain (0.01 to 0.015 Gm.), given an hour before meals, sometimes yields good results. Forlanini in these cases, when associated with **hyperchlorhydria**, irrigates the stomach with a solution of silver nitrate, 10 to 30 grains (0.6 to 2 Gm.) to the quart (liter), followed immediately by sodium chloride solution.

Experiments and clinical experiences showed that silver nitrate has the property of increasing the acidity of the gastric juice. It is indicated in **hypochlorhydria** and in **mucous gastric catarrh**. It aids in the digestion of protein. The drug may be used to advantage in **abnormal fermentation**. It promotes the emptying of the stomach. These various effects were observed with small doses ($\frac{1}{32}$ grain—0.002 Gm.—three times a day), as well as with large amounts ($\frac{1}{2}$ grain—0.03 Gm.—three times a day). Baibakoff (Archiv f. Verdauungsk., Bd. xii, nu. 1, 1906).

Catarrhal jaundice has been relieved by $\frac{1}{12}$ -grain (0.005 Gm.) doses of silver nitrate. F. Ehrlich has recommended (1902) the introduction of a 1 per cent. solution of the salt into the stomach, after preliminary lavage with warm water, in **angiocholitis**, **cholelithiasis**, and **cholecystitis**. The solution is withdrawn after one-half to two minutes, the process repeated, and washing with plain water then continued until a clear fluid returns. The remedy is asserted to act as a cholagogue and to relieve the symptoms, sometimes after preliminary aggravation.

Use of silver nitrate recommended in all irritative conditions of the gastric mucosa with increased secretion, hyperacidity, nausea, vomiting, and pain. In gastric neuroses, however, the drug exerts no influence whatever. In the **hyperchlorhydria**

frequently occurring in **chlorosis**, various diseases of the liver, **cholelithiasis**, **cholecystitis**, the early stages of **nephritis**, and reflexly in **constipation**, especially of the spastic type, and in **mucous colitis**, treatment should be chiefly directed to the primary disease, but for the alleviation of the symptoms silver nitrate is valuable.

In **benign pyloric stenosis** with retention of the gastric contents and decomposition of the retained ingesta, the most effective symptomatic treatment is thorough lavage followed by silver nitrate internally. In **fissure at the pyloric orifice**, lavage followed by silver nitrate, a non-irritating diet, and olive oil on an empty stomach, has never failed, in the author's experience, to effect a cure. For the pain of **gastric ulcer**, acute or chronic, silver nitrate is superior to any other drug. The heartburn, sour eructations, headache, and constipation are also promptly relieved.

Silver nitrate is always well borne by the stomach. In a case of severe **hemorrhage from gastric ulcer** in which the patient suffered intensely from sour eructations and laryngeal spasm, silver nitrate relieved both these symptoms after the second dose. In **chronic acid gastritis** silver nitrate acts as in other forms of hyperacidity. In **alcoholic gastritis** during the hyperacid stage it should also be employed. It is important in all forms of gastritis to wash the stomach thoroughly before the drug is given.

The writer usually gives the drug in solution in doses of $\frac{1}{4}$ to $\frac{1}{2}$ grain (0.016 to 0.03 Gm.) three times a day on an empty stomach. No food or drink is followed for half an hour after its administration. It is rarely necessary to continue longer than three weeks, though in rebellious cases it may be given for a month without danger of argyria. Where the intestines react unfavorably it should be discontinued at once. H. Weinstein (N. Y. Med. Jour., Dec. 28, 1907).

In ulceration of the cecum or rectum and in acute and chronic dysentery, rectal or colonic injections of silver nitrate are of value. If the cecum be involved a large bulk must be used to reach the seat of the trouble; if the rectum is the part affected not more than 4 ounces (120 c.c.) should be used. In either case there should be given preliminary cleansing injections of warm water. If the condition is cecal, one may use 1 dram (4 Gm.) of silver nitrate to 3 pints (1500 c.c.) of water; if rectal, 5 grains (0.2 Gm.) to 4 ounces (120 c.c.).

If the rectal disturbance is chronic and very obstinate, the strength may be increased to 5 grains (0.3 Gm.) of the salt to 4 ounces of water. A solution of common salt should be at hand, to be injected if the action of the silver is too severe, or to stop the action of the remedy when the desired effect has been produced.

The antiseptic and astringent properties of protargol proved effective in several cases of **gastroectasia** with **pyloric stenosis**, the fermentation, pyrosis, and vomiting being checked. Improvement was also noted in **chronic catarrh**, **gastric ulcer**, and even in **carcinoma**. Several cases of **dysentery** and **pseudodysentery** were rapidly cured by intestinal lavage with a 2.6 per cent. solution of protargol. For the **enteritis of children** $\frac{1}{2}$ to $\frac{3}{4}$ pint (250 to 300 c.c.) of a 2 per cent. solution were employed. For gastric lavage a 2 per cent. solution is used. It is advisable to wash out first with water, then to introduce 1 quart (liter) of the protargol solution. After eight or ten minutes, this is again washed out with water. For intestinal lavage, a preliminary washing with water is not necessary. Cantani (Gaz. degli osped., No. 138, 1910).

Nervous Disorders.—Silver has been used in anterior and posterior **spinal sclerosis**, and in **epilepsy** and **chorea**, but with little or no favorable effect, except possibly as a general tonic.

In **tabes dorsalis** Curci has claimed good results from the use of a double salt, the thiosulphate (hyposulphite) of sodium and silver. He gives daily from $\frac{3}{4}$ to 3 grains (0.048 to 0.2 Gm.) by mouth or from $\frac{1}{6}$ to $\frac{3}{4}$ grain (0.01 to 0.048 Gm.) hypodermically. He asserts that this treatment does not cause argyria.

Surgical Disorders.—Fissures of the lips, tongue, nipples, rectum, and mucous patches and ulcers of the mouth yield readily to applications of a 60-grain (4 Gm.) to the ounce (30 c.c.) solution of silver nitrate applied carefully on a pledget of cotton or by means of a camel's-hair pencil. In some cases the solid stick does better. It is also useful in hemorrhage from leech-bites.

Boils and felons may be aborted by early application of a strong solution of silver nitrate.

The healing of **suppurating ulcers** and **wounds**, with large flabby granulations, is hastened by an application, every day or two, of the solid stick or strong solution. The surface of **indolent ulcers** may be touched lightly with the solid stick, or a line may be traced within and parallel to the margin of the ulcer every day or two, the ulcer being strapped with diachylon adhesive plaster during the intervals and the limb dressed with a roller bandage. **Indolent sinuses** from **buboes** or from **abscesses** may likewise be stimulated to healing with a strong solution or the solid stick.

Powdered silver nitrate recommended as a means of exciting the proliferation of granulations and the regeneration of epidermis over open wounds and ulcers. As an excipient the writer uses fullers' earth (bolus alba), sterilized by heating to 100° or 150° C. The mixture should consist of 1 part of silver nitrate to 99 parts of the earth. It is dusted on the raw surface (not extending over the parts already healed over), and renewed every second or third or fourth day, according to the amount of secretion and reaction of the tissues. When the wound is well on the way to epidermization the treatment should be interrupted from time to time and simple aseptic dressing applied. The treatment is recommended especially for burns, and for the healing of wounds following furuncles and other infective processes of the skin. Max. Barnett (Munch. med. Woch., Aug. 30, 1910).

Bed-sores can sometimes be aborted if, as soon as the surface reddens, it is brushed over with a 20-grain (1.3 Gm.) to the ounce (30 c.c.) solution of silver nitrate. This treatment is, however, frequently of no avail in paralytics.

Lymphangitis of the forearm resulting from a poisoned wound of the finger may be cured by applying the solid stick over the lines of inflammation.

Rovsing prefers silver nitrate to all other antiseptics for impregnating gauze and drainage wicks, and in the preparation of suture material, and uses it extensively in his clinic for these purposes.

Spasmodic esophageal stricture has been relieved by the use of a sponge probang saturated with a very weak solution of silver nitrate.

Cushing, Halsted, and Lexer highly recommend the use of silver foil as

a dressing for **granulating wounds**, and especially for **skin-grafts** and the incisions in **plastic operations on the face**. The silver leaf acts as an antiseptic and minimizes scarring.

The marked tolerance of the body tissues for metallic silver has led to its use in bone suturing and in the preparation of supporting filigree or chain for use in cases of **ventral hernia** or other varieties of weakened abdominal wall.

Miller recommends, as productive of good scar formation in **burns**, the use of an ointment of protargol, 45 grains (3 Gm.), dissolved in cold distilled water, 75 minims (5 c.c.), and mixed with 3 drams (12 Gm.) of dried wool-fat and 2½ drams (10 Gm.) of petrolatum.

Silver-foil platelets used over **wounds** where very inconspicuous scar is desirable. Wounds thus covered remain perfectly dry, even if left alone for a week to ten days, and epidermization is much accelerated. In **osteoplastic flaps** the scars are so faint they are scarcely visible. **Skin grafts** may be left untouched for a week to ten days, though occasionally blood and serum collect beneath some of the grafts. In granulating wounds, healthy granulations are rapidly covered over with epithelium under the foil, without the formation of much granulation tissue. They become flatter. The silver foil apparently has an inhibitory effect upon the growth of granulation tissue. The surface, when healed, is even with the surrounding skin. The silver foil is also advised in skin sutures beneath plaster-of-Paris casts. E. Lexer (Zentralbl. f. Chir., Bd. xlii, S. 217, 1915).

Disorders of the Respiratory Tract.

—**Acute pharyngitis** may be aborted by the early application of a 60-grain (2 Gm.) to the ounce (30 c.c.) solu-

tion. In **laryngitis** the parts should be cleansed with an alkaline solution, the parts anesthetized with a solution of cocaine, and by the aid of a brush and mirror a 10- or 20-grain (0.65 or 1.3 Gm.) to the ounce (30 c.c.) solution of silver nitrate applied to the larynx.

In **laryngeal tuberculosis** a spray of silver-nitrate solution in the strength of $\frac{1}{2}$ to 2 grains (0.03 to 0.12 Gm.) to the ounce (30 c.c.) may be of service. Crocq claims that silver nitrate is a valuable remedy in **pulmonary tuberculosis**, promoting appetite and digestion and diminishing cough, expectoration, and night-sweats. He administers from $\frac{1}{4}$ to $\frac{1}{8}$ grain (0.008 to 0.02 Gm.) daily, in divided doses. It may, with advantage, be given in a $\frac{1}{10}$ -grain (0.01 Gm.) dose combined with 3 grains (0.2 Gm.) of Dover's powder.

In **pertussis** Ringer advised the use of a spray of silver-nitrate solution ($\frac{1}{2}$ to 2 grains—0.03 to 0.3 Gm.—to 1 ounce—30 c.c.) to relieve the violence of the cough and give the patient rest at night. The spray should be used when the stomach is empty, as it may bring on retching. The nozzle of the atomizer should be placed well within the mouth to prevent staining of the skin.

In **atrophic rhinitis** and **ozena**, Gleason obtained good results by painting a 20 per cent. solution of argyrol over the affected area.

Ophthalmic Disorders.—Silver nitrate is found useful in ophthalmological practice in all strengths from a 1-grain (0.06 Gm.) solution to the solid stick.

In **simple conjunctivitis**, where the discharge is profuse, a 2- to 5-grain (0.13 to 0.3 Gm.) solution is of value.

In **purulent**, including **gonococcal ophthalmia**, when the discharge is profuse, the lids should be everted and wiped dry, and painted with a 10- to 15-grain (0.6 to 1 Gm.) solution of silver nitrate, immediately neutralized with a solution of common salt. This should be done once daily.

Protargol is more satisfactory than either argyrol or silver nitrate for the treatment of **acute mucopurulent conjunctivitis** due to the Koch-Weeks bacillus. Argyrol is better than silver nitrate. Protargol is perfectly safe up to 33 per cent. Its application causes much less pain than silver nitrate, but more than argyrol. The solution was freely used and the excess left in the eye. It was always applied with small pellets of absorbent cotton. Drops for home use were always given—silver nitrate in 0.2 per cent. strength, or argyrol or protargol in 5 per cent. solution. Butler (Ophthalmoscope, Jan., 1907).

Many more cases of conjunctival argyria result from the use of organic silver compounds, such as protargol and argyrol, than from silver nitrate. The writer protests against the almost universal use of such compounds in acute and chronic catarrhal conjunctivitis. For these conditions a collyrium containing $\frac{1}{2}$ grain (0.03 Gm.) zinc sulphate and 10 to 12 grains (0.65 to 0.77 Gm.) of boric acid to the ounce (30 c.c.) is more surely and promptly efficacious than the silver compounds mentioned. S. Theobald (Johns Hopkins Hosp. Bull., Nov., 1911).

Granular lids and **trachoma** are benefited by silver nitrate. If there is slight discharge the stick should be used; if there is copious discharge, the use of a 10-grain (0.6 Gm.) solution, with neutralization of excess, once daily will be followed by improvement.

In **blepharitis**, Hinshelwood recom-

mends the use of argyrol, a strong solution of which is rubbed into the lid margins after each has been cleaned of crusts with a camel's-hair brush cut short. This procedure is applied at first daily, then every second or third day.

In diphtheritic conjunctivitis, after the absorption of the membrane and the re-establishment of the discharge, one may cautiously use silver-nitrate solution as in purulent ophthalmia.

Credé initiated the use of a 1- or 2- per cent. solution, 1 drop in each eye, in the eyes of all newborn infants to prevent the occurrence of ophthalmia neonatorum. This is, by many, made a routine procedure. Where all possibility of infection of the birth canal can be excluded, flushing out with a saturated boric acid solution is sufficient.

Silver nitrate cannot be used safely in the eye in a solution stronger than 3 per cent. A 2 per cent. solution, even if neither neutralized or washed out, never causes any irritation. Any solution stronger than 3 per cent., unless at once neutralized with salt solution, leaves a faint film of destroyed epithelium, especially in infants (Butler).

The use of silver should be interdicted where corneal ulceration exists, and when continued use of a remedy is desired. The danger of permanently staining the tissues must not be forgotten.

In place of silver nitrate, protargol (5 to 20 per cent.) and argyrol (5 to 50 per cent.) are often used. Their advantages consist essentially of less irritant power and greater ease of employment, but their antiseptic power is decidedly inferior. Neither (especially argyrol) should be depended

upon to overcome the more severe infective conjunctival inflammations.

Cutaneous Disorders.—It is claimed that pitting in smallpox may be prevented by puncturing the vesicles, on the fourth or fifth day, with a needle dipped into a 4 per cent. solution of silver nitrate. Others paint the skin with a 1 or 2 per cent. solution, and claim that it is equally effective. The mitigated stick has also been used.

Silver nitrate is also used to destroy parasitic fungi, to cause exfoliation of the epidermis, or for a local stimulant effect. As a caustic it is inferior to several other agents. It has been found useful in some forms of eczema (chronic forms and circumscribed patches), and in relieving the itching of prurigo and lichen. Pruritus ani and pruritus vulvæ may be benefited by a 4- or 6- grain (0.25 or 0.4 Gm.) to the ounce (30 c.c.) solution painted upon the parts two to four times daily.

The use of silver nitrate has also been recommended in lupus, psoriasis, erythema, ringworm, and erysipelas.

Venereal Disorders.—In the treatment of buboes good results have been reported from injections of a 2 per cent. solution of silver nitrate in the early stage.

In orchitis and epididymitis a strong solution of the nitrate painted over the scrotum, in the early stages, will often relieve the pain and reduce the swelling.

Injections of silver-nitrate solutions are most useful in the later subacute stages of gonococcal urethritis, in the strength of 1 part of the salt in 500 to 3000 parts of water, beginning with the weaker solution. Strong solutions used early have

been advised for the purpose of aborting the disease; such use is, however, not to be commended.

Fifty-five men, suffering from gonorrhea, were treated with injections of protargol, beginning with $\frac{1}{4}$ to $\frac{1}{2}$ per cent., and increasing in strength to 1 per cent. The patients washed the urethra out with warm water before injecting the protargol. The protargol injections were kept at first for ten minutes, and later up to thirty minutes. Of the 55 patients, only 2 showed signs of irritation. The average time occupied in causing the gonococci to disappear finally from the discharge was 16.3 days.

Five children with gonorrheal vulvovaginitis were treated with 2 per cent. solutions for the acute stages and 5 per cent. for the subacute stages. The parts were cleaned and the solution injected into the vagina and kept there for ten minutes, the pelvis being raised. None of the children complained of irritation. Sitz baths were employed as a supplementary treatment. It took on an average of three months before the last cocci were removed from the secretion of the vagina and cervix.

Protargol yielded as good or better results in female gonorrhea than other means. The writer employed it in solutions of from 5 to 10 per cent., and met with no irritating effect. Irritant effects are probably due to worthless imitations of protargol, and at times to the solutions not being made up freshly with cold water. C. Stern (Deut. med. Woch., Feb. 7, 1907).

The drug is also useful in 1:500 to 1:5000 strength in prostatitis, seminal vesiculitis (after massage), and the cystitis of enlarged prostate, or bladder stone or tumor.

Gynecological Disorders.—In ulceration of the cervix, and in those cases of leucorrhea in which the cervix is boggy and tender, great benefit may follow the application of

the solid stick within the cervix. This procedure is frequently followed by headache about the vertex, but this can be relieved with 10-grain (0.6 Gm.) doses of the bromides. Silver-nitrate solutions were used very extensively for erosions of the cervix, but other remedies have supplanted them. Vomiting of pregnancy can sometimes be relieved by brushing the cervix over with a 60-grain (4 Gm.) solution of the nitrate.

Removal of Silver Stains.—Silver stains on clothing may be washed off with a solution containing 45 grains (3 Gm.) of potassium cyanide, 5 grains (0.3 Gm.) of iodine, and 1 ounce (30 c.c.) of water. Another method is to dissolve 15 grains (1 Gm.) of corrosive sublimate in 7 ounces (210 c.c.) of boiled water, and add about 45 grains (3 Gm.) of sodium chloride just before using; the stained material is to be placed in it for about five minutes and then washed two or three times. Hahn advises the use of a solution containing 75 grains (5 Gm.) each of corrosive sublimate and of ammonium chloride dissolved in 10 drams (40 c.c.) of water.

When the stains are older they may be rubbed with a mixture of iodine and ammonia, and the part, still wet, then washed thoroughly. (When dry, it is highly explosive.)

Potassium cyanide in solution will generally remove stains from the fingers or skin. The part should be well rinsed immediately afterward. Or, the skin may be covered with tincture of iodine and then washed off with a solution of sodium thiosulphate (hyposulphite).

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SINUSES, NASAL ACCESSORY; DISEASES OF.

The nasal accessory sinuses, the maxillary, or antrum of Highmore, the frontal, ethmoidal and sphenoidal, are commonly involved in various disorders: acute and chronic rhinitis, the various diseases of childhood, and also in pneumonia, influenza and typhoid fever, through extension of the infection to them. Especially is this apt to be the case when septal deviation, nasal polypi, turbinate hypertrophy, or any other condition capable of interfering with proper drainage of the nasal cavities is present. These conditions may also provoke chronic inflammation of the sinuses, due to accumulation in them of secretions containing pathogenic bacteria. It may also be caused by chronic catarrhal disorders, in which intumescence of the nasal mucosa is more or less permanent, and characterized by mucopurulent discharge. The source of infection may be located in the mouth. Not only may carious teeth awaken suppuration of the antrum when, as in the case of certain bicuspid and molars, this sinus is penetrated by the roots of teeth, but also through germs such as the end-ameba, pneumococcus and other organisms concerned with pyorrhea alveolaris. Tonsillar streptococci are also thought to prove pathogenic in some instances. Syphilis, tuberculosis, carcinoma, sarcoma and other destructive processes may also extend to, or occur in, either of the sinuses. Their bony framework may be involved in fractures, punctured wounds and other traumatisms.

The pathological changes induced are characteristic. Although the mucosa covering the walls of the various

sinuses is hardly one twenty-fourth of an inch thick, inflammation with the accompanying edema may cause it to swell to eight or nine times this thickness, and to become polyp-like. The cavity becomes more or less occluded as a resonance chamber, while the pressure exerted centrifugally by the swollen mucosa upon its walls may cause pain, such as that produced in the frontal sinus in the course of influenza, in the antrum during a local inflammation, etc. The first mucoid secretion soon becomes replaced by mucopus, unless arrested in the first stage, owing to invasion by pyogenic bacteria and phagocytes. While this may occur in any sinus, the frontal and maxillary sinus, or antrum of Highmore, are the seats of predilection for a purulent process.

Important in this connection is the formation of fistulous openings where the orifices of a sinus are occluded sufficiently by the swollen mucosa to prevent the discharge of pus. These openings, which occur through the thinnest and weakest portion of the walls of the sinus, may entail severe complications, such as orbital cellulitis, infection of the cranial contents, meningitis, periostitis of the osseous tissues adjoining the sinuses, etc. Disorders of the nasal accessory sinuses, therefore, may prove dangerous to life if neglected.

MAXILLARY SINUS OR ANTRUM OF HIGHMORE.

INFLAMMATORY DISORDERS.—The maxillary sinus may be seat of *acute* or *chronic* inflammation.

Acute Inflammation.—This disorder may occur as an extension of an acute rhinitis or some inflammatory disorder of the anterior nares,

through the antral opening below the middle turbinate, the invasion of pus, irritating powders or fumes, insects, foreign bodies, etc., or occur as one of the manifestations of a general infection or toxemia.

The main symptom is a neuralgic pain referred to the cheek of the affected side. It presents as a characteristic feature that of being most severe in the region of the malar bone. If the nasal disorder be such as to occlude, by swelling, the ostium maxillare, the pain may be severe and extend to the orbital region. The pain may also affect the upper dental arch, even though the teeth of the corresponding area be normal, owing to the tension in the antral cavity.

All these symptoms become aggravated where the antral exudate becomes purulent. The teeth which bury their roots in the lower portion of the antrum, and adjoining teeth, give rise to severe pain on being percussed. While a diseased tooth—either the second bicuspid or first molar—in most instances is a frequent cause of antral sinusitis and abscess, the determination of this fact should be left to a competent dentist. Sound teeth have often been removed by incompetent or careless operators.

The antrum, owing to its size, is the most prolific source of *discharge* of all the sinuses. At first mucoid and gelatinous, it eventually assumes a mucopurulent character, and is voided through the nasal orifice if the latter be patent and into the nose, and drawn thence into the nasopharynx and expectorated or swallowed, especially if the nasal passage of the corresponding side be obstructed, or if the patient is in the recumbent position. If the nasal cavity

is relatively patent, the discharge is voided anteriorly. It is apt to have a foul odor if the cause of the antral purulent process be due to diseased teeth. When the discharge is pent up in the cavity through blocking of the nasal orifice a *fistulous opening* is formed unless the mucopus be artificially removed or resolution occur spontaneously. The pus may break through the nasal wall, forming a fluctuating tumor in the middle meatus, *i.e.*, under the middle turbinate, or through the lower portion of the anterior wall of the sinus, and escape in the sulcus between the gum and the cheek above the first or second molar.

Chronic Inflammation, or Empyema.—This condition results from the acute form when it fails to disappear spontaneously or remain untreated. The membrane then becomes organized, thickened, irregular and polypoid in character, polypi sometimes projecting through the antral orifice beneath the middle turbinate. In most cases, however, this orifice remains patent, and gives passage to a *free discharge* which is found in this location, *i.e.*, the middle meatus, the elimination of which, anteriorly or posteriorly, is subject to the same conditions as in acute sinusitis. Exacerbations of discharge occur along with temporary catarrhal symptoms. At times the mucopus eliminated is very fetid and imparts its fetor to the patient's breath. But little, if any, pain is complained of, and general phenomena, fever, etc., are seldom observed.

Although some cases may undergo spontaneous resolution, the majority persist sluggishly during many years, undergoing periodical exacerbations

of activity. These may occur after apparent cure through appropriate measures, so that in all cases the prognosis should be guarded.

The diagnosis of antral inflammation is not difficult when the location of the pain, the presence of pus in the middle meatus, and marked sensitiveness of the teeth immediately beneath the antrum can be discovered. In most cases, however, transillumination—a strong electric light being placed in the mouth—should be used, showing as it does obstruction to light on the diseased side as compared with the relative free illumination on the normal side. It affords, at least, corroborative testimony. When both antra are diseased, an exploratory puncture of the suspected antrum beneath the inferior turbinate, under local anesthesia, may be resorted to, but only under strict antiseptic precautions. In marked cases empyema may be recognized after carefully spraying out the nose, by causing the patient to bend his head over to one side, when a marked accumulation of purulent exudation will appear in the uppermost nostril. Percussing the cheek and the teeth may elicit suggestive pain.

The writer questions the efficacy of transillumination as the deciding factor in determining antral suppuration, and places more dependence upon the suction syringe for diagnostic purposes. The specially devised needle is readily inserted, and nearly a syringeful of water is quickly injected into the cavity of the antrum, and at once sucked back into the syringe, in order to obtain a specimen of the antral contents. In a number of cases the writer's suspicions of antral suppuration were negatived by excellent transillumination, with pupil reflex, whereas, the

use of the syringe revealed the presence of thick pus in greater or less amount, or the existence of plugs of mucus with or without pus. Williams (*Jour. of Laryn., Rhin., and Otol., Mar., 1912*).

When from any cause, the nasal opening of the antrum becomes occluded—through swelling of the nasal membrane, polypi, plug of purulent material, diphtheritic membrane, etc.—all the symptoms, especially the pain and swelling, become progressively worse. The pain finally becomes intense, while the swelling includes bulging of all neighboring parts, the cheek, palate, gums and teeth, eyeball. Symptoms of pyemia, chills, sweats, and high fever also appear. Thinning of the walls of the sinus progresses, however, and finally rupture occurs either through the palate, alveolar process, orbit or nasal cavity. As soon as the pus is evacuated in this manner all the symptoms disappear, apart from those of the remaining chronic inflammation described above, and a more or less permanent fistula.

In an examination of 100 heads in the necropsy room, the writer found that 37 per cent. showed some evidence of pathological changes in the maxillary antra. Of these 37 cases, 11 were examples of edema; 12 were examples of chronic inflammation or empyema; 1 was an example of an alveolar or dental cyst, and 13 were examples of retention cyst. With one or two exceptions, all of these cases were undiagnosed during life. The presence of a large amount of pus in 10 out of 12 of these cases of empyema may have played an active part in causing the death of the patients. J. P. Tunis (*Laryngoscope, Oct., 1910*).

TREATMENT.—In all the phases of antral inflammation careful atten-

tion should be given to the nasal cavity. Acute cases and exacerbations of activity in chronic cases may often be checked if seen early when a nasal inflammatory disorder is the cause, by thorough cleansing with warm **saline solution**, used freely with a coarse atomizer, followed by the local application, with a pledget of cotton on a nasal probe, of the **glycerite of iodotannin**, which is prepared as follows:—

<i>R. Iodi</i>	℥ss (2 Gm.).
<i>Acidi tannici</i>	℥ss (15 Gm.).
<i>Aque</i>	Oss (250 c.c.).
M. Filter and evaporate to ℥ij (62 c.c.) and add	
<i>Glycerini</i>	℥iiv (125 c.c.).

This solution is applied freely over the nasal mucosa, and particularly under the middle turbinate, the area forming the middle meatus into which the orifice of the antrum opens. If the tissues are swollen, the application of the above should be preceded by a spray of 4 per cent. solution of **co-caine** to contract it and anesthetize it. This treatment should be carried out by the physician daily. The patient should then be shown how to use drops into the nose in such a way as to cause them to bathe the outer wall, including the space under the middle turbinate, *i.e.*, by bending his head well over on side of the sinusitis. He should then be ordered to spray his nose carefully night and morning with saline solution to cleanse it, then to apply 5 or 6 drops of 1:5000 solution of **adrenalin** into the nostril of the affected side, and after a few minutes follow this up with a spray of the following oily solution:—

<i>Camphor</i> ,	
<i>Menthol</i>	℥ss gr. j (0.06 Gm.).
<i>Bengaiol</i>	℥ij (62 c.c.).

In mild or incipient cases due solely to the presence of an inflammatory disorder in the cavities, this mild treatment, if persisted in, suffices to check the antral trouble. It should be remembered that polypi, hypertrophy of the middle and inferior turbinal, a foreign body, etc., may prove to be the exciting cause, and that appropriate treatment of these conditions is necessary.

The teeth, the roots of which project into the sinus from below, being occasionally the source of antral inflammation, they should be carefully examined. Mere sensitiveness under percussion does not warrant a conclusion that they are the source of trouble, since inflammation of nasal origin may also cause neuralgia in the upper dental arch. Teeth should only be drawn, therefore, after an X-ray has clearly shown them to be the cause of the antral disorder. Since the recognition of the fact that pyorrhea alveolaris is present in most persons after the thirtieth year, especially in view of the resistance of the *Endameba buccalis*, a communication between the mouth and the antrum should be avoided when at all possible. It is probable, in fact, that the persistence of empyema treated in this manner and necessitating a permanent tube or plug in the alveolar perforation is due to constant reinfection by gingival organisms. When, therefore, the exciting cause is clearly traced to a tooth and it becomes necessary to extract the latter to irrigate the sinus, it is best to **pack the opening with iodoform gauze**, and to repeat the irrigations a few times. If this does not suffice to cure the antral disorder—which it often does in recent cases—it is preferable to allow

the alveolar opening to close and to create an opening through the nasal wall.

The alveolar operation should never be done as an operation of choice, because it establishes a communication between the mouth and a suppurating cavity, and requires the use of a tube or plug, which is decidedly disadvantageous. The open method of doing the canine fossa operation is likewise to be condemned on much the same grounds. When simple irrigation has failed or is not practicable, the next step should be a large opening in the inferior meatus, with removal of a portion of the inferior turbinate. If this method is employed, very few patients will require radical operations. Wells (Laryngoscope, Dec., 1906).

Having encountered a case of fatal bleeding in entering the antrum with a sharp trocar through the inferior nasal meatus, as well as occasional infections of the pterygomaxillary fossa from excessive momentum of the instrument and accidents from entrance of the point of the trocar into an orbital cell, the writer determined to discard the sharp-pointed trocar for a smooth-tipped rasp modelled after those used by Vacher and by Watson Williams for penetrating into the frontal sinuses. An opening large enough to facilitate irrigation and avoid premature closure is thus made. Luc (Rev. de laryng., d'Otol. et de rhinol., May 15, 1918).

Although the ostium maxillare is most easily reached and penetrated, its situation, in the middle meatus, *i.e.*, under the middle turbinate, would cause a trocar to enter the antrum too high up to permit of effective drainage through the nose. It is preferable, therefore, to puncture the thin wall of the antrum which faces the area beneath the inferior turbinate. A pledget of cotton well-moistened, a 10 per cent. solution of

cocaine having been placed in this location and left there about ten minutes, a Coakley or Myles trocar and cannula, sterilized by boiling, is introduced upward and outward under the inferior turbinate until one inch of the instrument from the lower edge of the nostril has entered the nose. The trocar is then pushed in through the wall into the antrum, then withdrawn, leaving the cannula *in situ*. Through it the antrum can be drained, then washed out by means of syringe with saline solution, and again drained dry—a measure which often suffices in recent or mild acute cases to effect a cure.

Efforts must be chiefly directed to promoting the free and spontaneous discharge of pus from the antrum by way of the natural ostium, by: (a) directing the patient to lie in bed with the diseased antrum uppermost; (b) the application of cocaine and adrenalin solutions to the regions around the middle meatus—this may be done every four or six hours; (c) scarification of these regions; and (d) inhalation of mentholized steam. If these means fail the antrum should be punctured through its inner wall in the inferior meatus, and irrigated. Tilley (Brit. Med. Jour., Aug. 22, 1908).

It should be borne in mind, however, that the anatomical relations of the frontal and ethmoidal cells with the antrum render the latter a sort of receptacle for discharges from the former. When all these structures are diseased, therefore, drainage of the antrum in the manner described is useful in several ways.

In those cases in which the entire chain of cells is diseased—the antrum, the ethmoidal cells, the frontal sinus, and in many cases the sphenoidal sinus also—Jansen has proposed the extensive external opera-

tion of laying open the entire chain. This operation is only called for and only warranted in extreme cases in which the cavities are the seat of myxomatous or other growths. In all ordinary cases of empyema of the antrum and ethmoidal cells, associated with nothing more than a degenerated condition of the mucous membrane that has resulted from a prolonged maceration in pus, these external operations are, in the opinion of the writer, unnecessary, for the reason that diseased conditions of the maxillary sinuses, and also of the ethmoidal cells, which are commonly associated with an empyema, can be successfully treated by the nasal route. J. O. Roe (Annals of Otol., Rhin., and Laryn., June, 1909).

It is sometimes necessary, owing to the necessity of keeping the artificial opening patent for continued drainage and local treatment, to enlarge the opening. This necessitates removal of the lower anterior portion of the inferior turbinate. **Wells's operation** is much used for this purpose. In this procedure the anterior half of the inferior turbinate is first removed under local anesthesia with a 10 per cent. solution of cocaine and ischemia with 1:5000 solution of adrenalin by means of serrated scissors and the snare. An opening is then made with a trocar, as explained above, but lower down and close to the floor of the nose. This opening is then enlarged by means of a rasp, used in such a way as to extend the opening anteriorly, following the line of the nasal floor until the junction of the nasointral with the facial wall of the antrum is reached.

Skilern's operation obviates the necessity of resecting a portion of the inferior turbinate. It is performed as follows: After cleansing the nasal cavities, anesthesia is secured by the

application of a 20 per cent. solution of cocaine and by injections of novocaine and adrenalin. A spindle-shaped piece of mucous membrane is removed in front of the inferior turbinate by two incisions extending through all the tissues to the bone, and the crista pyriformis is exposed. With a chisel, forceps and an electric trephine the antrum is then opened, flushed out, inspected, curetted, and packed loosely with iodoform gauze. The gauze is removed in forty-eight to seventy-two hours and replaced every second day for two weeks. This operation enables the operator to inspect directly the sinus and to follow *de visu* local applications to any part of the diseased area, including some that are usually resistant to treatment.

In acute maxillary sinusitis one should irrigate the cavity as suggested for empyema; this failing, it may be necessary to make a wide artificial opening in the lower part of the nasointral wall for ventilation. In chronic maxillary sinusitis one should make a wide artificial opening in the nasointral wall; this failing, one should expose the sinus through the facial wall, and curette the interior. Wells (Med. Rec., Oct. 29, 1910).

We have seen that inflammation of the mucosa of sinuses causes it to thicken greatly and to form polypoid projections. In the presence of pus this thickened mucosa becomes a soggy mass which requires the conservative use of the curette—not the vigorous curetting which the late John O. Roe has very properly condemned—the snare for polypoid masses, and the application of remedies to all parts of the diseased cavity. This can only be done by means of an operation which enables the

operator to reach the sinus through the mouth and nose. Such a procedure, known as the **Caldwell-Luc operation**, is begun in the mouth by means of an incision in the sulcus between the gum and lip above the bicuspid and first molar. The periosteum being detached up to the infra-orbital canal, an opening is drilled into the antrum as starting for removal, by means of rongeur forceps and chisel, of the greater portion of the anterior wall of the sinus, forming a gap through which the index finger may easily be introduced. Through the oroantral opening thus made a disk of bone about one-half inch in diameter is removed from the nasal wall, including the anterior half of the inferior turbinate.

Besides permitting any curetting or snaring that may be necessary, this operation affords a free field for local treatment. Irrigations with **saline solution**, followed by **insufflations of iodoform** over all parts of diseased surface, and packing with **iodoform gauze** daily for a week or ten days, will usually deal effectively with a case of empyema. The oroantral opening may be closed by sutures after free drainage and the use of the curette or snare, and the medical treatment carried on through the nasal opening. At times stimulation of the antral membrane is necessary; this may be done by using a spray of 25 per cent. solution of **argyrol**. Irritant antiseptics and astringents are more harmful than beneficial in antral diseases.

Removal of a tooth, unless it can be demonstrated to be the offending member, is bad practice. The author advocates an examination through a sufficiently large opening in the anterior wall. He was led to adopt this

procedure by his experience in operating by the Luc-Caldwell method, when he frequently found a mass of granulation tissue in the floor of the antrum which often led to an abscess about the apex of a tooth. A. R. Solenberg (Colo. Med., xii, 269, 1915).

TUMORS OF THE MAXILLARY SINUS, OR ANTRUM.

Polypi.—The tumors most frequently found in the antrum are polypi, which, as stated above, often occur in cases of empyema of long-standing. They may either develop in the antrum itself or project out of the antrum into the nose and develop under the middle turbinate.

Cysts.—These are of two kinds. The one, developed from the mucosa of the antrum, gives rise to periodical discharges of a watery, odorless fluid, and, when sufficiently large, to deformity and bulging of the affected side.

The second variety arises from an alveolus, and is due to cystic degeneration of the peridental membrane. It causes erosion of the antral wall, penetrates the antrum by pushing its mucosa before it, then grows rapidly, soon filling the cavity, and causing deformity of the face and palate on the corresponding side. A characteristic crackling sensation is elicited by compressing its outer wall. If it ruptures it yields a greenish, thick, odorless fluid, containing, as a rule, cholesterin crystals. Unlike the other variety, there is no discharge in the nasal cavity, unless it ruptures, when, becoming infected, it simulates an empyema, giving off a fetid discharge.

Osteoma.—In this form of tumor, symptoms are only awakened when the neoplasm has grown sufficiently to compress the nasal wall, and thus

gradually decrease the lumen of the nasal passage of the corresponding side. No pain is experienced until a large size is attained, and no discharge of an abnormal character is complained of. An exploratory needle or trocar thrust into the tumor is arrested as soon as the mucosa is penetrated, and transillumination shows complete darkness as compared with the other side.

Malignant Tumors.—*Sarcoma* and *osteosarcoma* are the growths most commonly observed in the antrum. Cases of *psammo-sarcoma*, *epithelioma*, *perithelioma* (Sakai) and *endothelioma* have been reported. These tumors, particularly sarcoma, grow with relative rapidity and usually cause lancinating pain and considerable swelling. After filling the antrum, they penetrate into the nasal or nasopharyngeal cavity, rapidly decreasing their lumen and giving rise to a mucopurulent discharge often streaked with blood and detritus, and giving off a foul odor. The glands behind the angle of the jaws are enlarged soon after the nasal cavities are invaded.

Unique case, as a careful search of medical literature revealed none like it, of a calculus made up almost entirely of a calcium phosphate and found in the course of an operation for a squamous-celled epithelioma involving the antrum of Highmore. N. H. Carson (Interstate Med. Jour., Mar., 1913).

TREATMENT.—The removal of *polypi* from the antrum requires, as previously stated, sufficient room to render the use of the *curette* or *snare* possible. For this purpose the **Caldwell-Luc operation** affords the required room. This applies also to the removal of ordinary *cysts*. As regards

the *cysts of dental origin* an injection of a 2 per cent. solution of **phenic acid** into the cyst, through an incision above the diseased tooth if necessary, causes shrinking and disappearance. If the growth cannot be reached, the **Caldwell-Luc buccal opening** should be practised, and the cyst removed, including the offending tooth, if necessary.

Osteomata can only be removed satisfactorily by dissecting up the facial tissues from the antral wall and by means of chisel and gouge insure complete **excision** of the growth. This operation, which should, of course, be done under general anesthesia, is but rarely followed by recurrence. In *malignant growths* removal of the affected superior maxilla alone affords any hope of recovery.

FRONTAL SINUS.

INFLAMMATORY DISORDERS.—The frontal sinus may be the seat of *acute* and of *chronic* inflammation.

Acute Inflammation.—In this condition, especially when suppuration is present, there is more or less severe pain between and above the eyebrows, which presents the characteristic of being increased by leaning forward and by coughing and of being so aggravated on blowing the nose that the patient is apt to avoid emptying the nasal cavity properly. Percussion over the sinus also causes pain; this is likewise the case when pressure is exerted under the frontal sinus, i.e., on the orbital plate below the edge of the orbit under the supraorbital foramen. The whole superciliary region, especially over the course of the supraorbital nerves, is hyperesthetic. In mild cases a sensation of fullness

and weight in the frontal region is alone experienced. The discharge, at first serous, may become bright yellow and purulent, and pass down into the nasal cavity between the middle turbinate and the outer wall of the cavity, but if the orifice, the infundibulum, be obstructed, the sinus is distended, and a fistulous opening may form, or the abscess may break into and invade the neighboring anterior ethmoidal cells.

CHRONIC INFLAMMATION.—

Chronic inflammation of the frontal sinus may occur as a result of acute inflammation of the sinus, or, through extension, a chronic ethmoiditis, in which the anterior ethmoidal cells are ruptured through distention and allow their purulent contents to penetrate into the frontal sinus. An antral empyema may also act as primary cause. The antral mucosa undergoes polypoid thickening, and sometimes becomes the source of polypi which project into the nasal cavity and cause considerable annoyance. In most cases but little pain is complained of, a sensation of fullness or pressure above the brow, and some tenderness over the latter, being usually experienced. Swelling or bulging over the frontal sinus may also occur. There is, in most cases, considerable discharge which may be voided anteriorly or posteriorly, the patient complaining that he is suffering from "nasal catarrh." Periodical discharges of mucoserous or mucopurulent fluid may afford considerable relief.

Pent up, the discharge may cause rupture of the sinus and pass into the orbit, the nasal cavity, the dura mater, causing meningitis; or the lymphatics may serve as carriers of

pathogenic bacteria or purulent materials to the meninges. Edema and redness of the upper eyelid is usually present. Fistulous openings may also form anteriorly, *i.e.*, through the anterior wall of the sinus, opening above the inner canthus. The pain, when the suppuration is confined in the latter, is severe and constant, and often assumes a neuralgic or boring character. Or, persistent headache with insomnia may occur. The frontal region becomes markedly bulged, and in extreme cases one or both eyeballs may be displaced, causing diplopia. Even amaurosis has been caused through persistent pressure upon the eyeball. Systemic phenomena, suggesting pyemia chills, sweats, fever, etc., are often observed in severe cases. Persistent pressure may so reduce the thickness of the anterior walls as to make it possible sometimes to obtain fluctuation and crackling. Unless the pent-up discharge be removed surgically, rupture may occur and awaken the dangerous complications recited above.

The presence of a frontal abscess is not definitely shown by transillumination. An X-ray photograph affords a clear idea of the topography of the sinus, the diseased side appearing relatively dark. If the same area also appears dark under transillumination, the diagnosis of local disease is correspondingly strong. This is further strengthened if, on examining the nasal cavity, pus or polypi are found beneath the middle turbinate into which the infundibulum, the elongated outlet of the frontal sinus, opens.

TREATMENT.—An important feature of acute frontal sinusitis is that it is apt to develop in conjunc-

tion with the acute rhinitis attending various febrile disorders. In influenza, for instance, the pain about the brow is due to this cause. The local process is simply that of occlusion of the infundibulum, through swelling of its mucosa. The escape of the mucus to the nasal cavity being prevented, distention of the sinus and swelling of its mucosa follow, giving rise to the painful sensation. The aim should be, therefore, to free the sinus by opening it. This may be done with a spray of **warm saline solution** directed upward under the middle turbinal. A 2 per cent. solution of **cocaine**, containing 2 drams (8 c.c.) of the 1:1000 solution of **adrenalin** to the ounce (30 c.c.) is then sprayed in the same region, the patient *leaning forward* while using the spray in order to cause the fluid to flow into the infundibulum. After a few minutes, considerable relief will be experienced, owing to contraction of the tissues around the infundibulum, and a flow of mucus will soon follow. Repeated every two hours, this procedure will prevent suffering, unless polypi or hypertrophies prevent access of the remedial fluid to the frontal passage.

In a number of acute cases marked relief was obtained—because of the free rhinorrhea set up—from the intranasal use of the following solution: **Mercuric iodide**, 1 Gm. (15 grains); **potassium iodide**, 4 Gm. (1 dram), and water, 100 c.c. (3½ ounces). D. Macfarlan (Jour. Amer. Med. Assoc., Jan. 3, 1914).

The patient should be kept at rest and placed on a **light diet**, avoiding stimulants, coffee, etc., to keep the blood-pressure within its normal limits. Drugs, such as opium, belladonna, etc., which tend to cause dry-

ness of the mucous membranes, should be avoided. **Saline purgatives** should be used if the bowels are not free. The **biniodide of mercury** in ½₂₀-grain (0.003 Gm.) doses three times daily shortens the purulent process by enhancing the antitoxic and bactericidal properties of the blood. **Hexamethylenamine**, 4 grains (0.26 Gm.) three times daily, has been recommended.

The same local treatment sometimes proves useful in chronic cases, when used four times daily, the fourth time on retiring, giving also the **biniodide of mercury**. If it fails, the frontal sinus cannula should be introduced into the sinus, and the frontal sinus washed out daily with **saline solution**, the patient being taught to use the cannula and to wash out the sinus also on retiring. In most cases the cannula is easily introduced by passing its curved tip upward under the anterior end of the middle turbinate. When this does not suffice to insure proper drainage and restore the sinus to its normal condition, removal of anterior portion of the middle turbinate with cutting forceps is indicated. This provides free access to the sinus for local treatment by injection of 20 to 30 minims (1.25 to 1.8 c.c.) of a 10 per cent. solution of **argyrol** after careful washing with the warm saline solution.

When these less radical methods prove insufficient for proper drainage, **opening of the sinus through its anterior or inferior wall** becomes necessary. When this is done, enough of the wall must be removed to permit a thorough examination of the cavity, and enlargement of the nasofrontal duct to an extent sufficient for free drainage into the nose. If

operation is delayed too long, the continued pressure may cause rupture through the floor into the orbit or through the posterior wall of the sinus into the brain-cavity, with consequent purulent meningitis or brain abscess.

The surgical treatment of fronto-ethmoidal sinusitis has progressed through many changes. To cure frontal sinusitis and prevent its recurrence it is necessary to eradicate the cavity. The ethmoid is approached by the endonasal route so that when the frontal sinus is opened all that remains to be done is to enlarge the nasofrontal canal at the level of the infundibular region for free drainage. The modification of the Ogsten-Luc operation is less mutilating and furnishes excellent drainage. A rather large bony opening is made at the level of the frontal boss in order that the whole frontal cavity may be inspected and curetted completely. E. J. Moure (*Laryng.*, xxxi, 479, 1921).

Such operations should be performed only by a highly trained specialist, as otherwise they are fraught with danger.

The indications for the **external operation** of the frontal sinus may be divided into absolute and relative. Absolute indications are: (1) Where the disease has made such progress as to seriously threaten some neighboring organ, and even life itself is threatened, or there are actual cerebral and orbital complications. (2) When the subjective symptoms are severe enough to interfere with the business pursuits of the patient. (3) When severe exacerbations occur. (4) In abscess or fistula formation.

Relative indications are: (1) When the headache continues with no apparent change in the amount or consistency of the secretion. (2) When despite frequent irrigations the pus continues fetid, even though diminishing slightly in amount. (3) When the X-ray shows a large sinus with

many ramifications and the disease does not appear to yield satisfactorily to internal treatments.

As to the type of operation, this is often determined by the pathological change present or the anatomical configuration of the sinus. Other things being equal, the writer performs his modification of the Jansen operation, in which he can spare the anterior wall, but obtain the requisite space. This is done by resecting the superior internal portion of the margin of the orbit and the floor of the sinus, thus exposing the entire lower portion or funnel of the frontal sinus. After this has been done the usual procedures are followed, i.e., removal of diseased mucosa, the ethmoid cells, and, if necessary, the sphenoid is opened. The communication with the nose may be enlarged to any desired size by merely removing the orbital plate piecemeal with the bone forceps. The wound is closed and dressed in the usual manner. R. H. Skillern (*Laryngoscope*, xxv, 212, 1915).

The writer believes that the **external (Killian) operation** on the frontal sinus has not fulfilled the brilliant hopes that were raised at the time of its introduction, and that the earlier successes reported have been discounted by instances of septic osteomyelitis, an almost universally fatal complication, even in the hands of skillful operators. In many cases very grave deformity has resulted, and, in addition, the operation often fails to give the relief sought.

Intranasal methods for obtaining drainage and space for lavage by the removal of the anterior end of the middle turbinate have long been practised and are of value, but are often, also, insufficient to effect a cure. To Ingals is due the credit of introducing the method of following up the frontonasal duct and entering the sinus through the normal ostium. All subsequent intranasal methods are developments of the Ingals operation. The author believes most of these to be dangerous, and advances

his own operation as being comparatively safe. He begins below and anterior to the middle turbinate and continues upward to the frontal sinus, "without destroying any part of the vertical plate of the ethmoid," a point he thinks of much importance, since he says it does not involve fracturing through the vertical plate in close proximity to the cribriform plate and laying open venules and lymphatics in this dangerous area to infection. The writer's operation may be done with cocaine, but he much prefers general anesthesia. His technique is simply to cut through the most anterior attachment of the middle turbinate with a conchotome and continue biting upward through the anterior cells to the crista nasalis. In the same manner the cells lying behind the duct are then removed to any necessary extent. Sounds are passed into the sinus and all projecting edges removed. Often this will suffice, but if enough room has not been secured by these measures, the nasal crest may be rasped away, but it is much preferable to use a guarded burr for this purpose. The advantage claimed for the burr is that the mucous membrane of the posterior wall is left intact and the bone only laid bare anteriorly.

He advocates the use of from 30 to 50 c.c. of polyvalent *antistreptococcus serum* immediately before the operation, followed by the administration of *sensitized vaccines*. Sounds should also be passed at regular intervals after the operation to insure the permanency of the opening made.

Over one hundred frontal sinuses have been treated in this way by the author, who claims that many have been cured and nearly all relieved. In a few instances he was unable to reach the sinus pernasally. P. Watson-Williams (Surg., Gynec. and Obstet., from Lancet, July 15, 1915).

As stated by Shurly some years ago, the surgery of the frontal sinus will become more conservative as

our knowledge grows. The relief should come, not through surgery alone, but from prophylaxis and the successful abortion of the common colds. An important feature of these cases is the careful treatment of chronic rhinitis in any of its forms (see NOSE, DISEASES OF, in the seventh volume). A change to a semi-tropical climate, such as that of Florida or Southern California, preferably near the seashore, sometimes proves curative.

TUMORS OF THE FRONTAL SINUS.

Mucocele.—Mucoceles are but retention cysts formed by closure of the infundibulum and the accumulation of the exudate within the sinus. This gives rise to a feeling of distention and neuralgic pain in the supra-orbital region, which is itself exceedingly sensitive to palpation. In some instances there is formed a polyp-like tumor of the swollen mucosa which is visible under rhinoscopic examination if a very small mirror be used, and sufficient often to form a myxoma-like tumor under the middle turbinate. In others, the pressure is also exerted anteriorly or laterally and by eroding the orbital wall causes displacement of the eyeball.

Case of an unusually large mucocele of the frontal and ethmoidal cells. The patient, a woman 69 years of age, was first examined November 25, 1914, for a supposed growth of the left orbit. There were two lumps the size of beans just below the brow, which coalesced and formed a marked prominence, displacing the eye outward and downward. There was no pain or evidence of inflammation, nor any appreciable derangement of vision. She gave a history of having had nasal catarrh several

years before, but had not been troubled since. Uncorrected vision was 5/7.5 in the right, 5/9 in the left. The fields of vision were normal. The proptosis of the left eye was about 1.5 cm. in advance of the right.

The periocular swelling eventually reached the size of a hen's egg and was systic to the touch. The rhinological examination showed a large cystic mass that had apparently destroyed the orbital wall of the frontal sinus. The left nasal fossa was free, although the lateral wall seemed more prominent than usual in the agger nasi region. Transillumination of the antrum was negative. The X-ray report was that the supra-orbital ridge was completely absorbed and the sinus enlarged upward on the frontal bone.

An external operation was performed with the incision through the brow and the sac exposed, the walls of which were found to be composed of thickened periosteum, which was filled with the frontal sinus contents. The bone of the anterior wall and floor of the sinus had entirely eroded away, and the ethmoid cells were exposed on the removal of this sac. These were partially exenterated and drainage established into the nose. The posterior wall was also eroded and the meninges were separated from the sinus only by the periosteum. Healing was prompt and without incident. In two weeks the wound was closed and the excursions of the eye were normal. Uncorrected vision was now 5/7.5 in each eye. W. C. Posey (*Ophthal. Rec.*, xxiv, 116, 1915).

Cysts.—Cysts similar to those observed in the maxillary sinus have occasionally been observed in the frontal sinus. They contain a greenish or brownish viscid fluid, sometimes wax-like, which is voided with difficulty when they rupture. A very gradual swelling, accompanied by little or no pain about the brow, is about the only symptom noted, even

though the osseous walls of the cyst are being thinned by pressure until palpation and slight compression imparts a crackling, parchment-like sensation to the finger.

Case of a cyst of the frontal sinus in a man of 56. The tumor had been growing fifteen years, the patient having refused operation until it measured 38 by 35 cm. An incision released 1800 Gm. of a reddish brownish fluid. The brain was found much compressed, while the bone had been worn away. The case is remarkable from the absence of brain symptoms and of pain or other sensation except the discomfort from the large tumor, although after its removal there was room for the fist between the skull and the brain. Herzenberg (*Deut. med. Woch.*, Nov. 4, 1909).

Osteoma.—Primary osteoma of the frontal sinus is rarely encountered. It grows very slowly, and finally produces considerable deformity of the face. At first the growth is insidious, but after a time neuralgia becomes a leading symptom, with, perhaps, undue sensitiveness over the growth; however, even under pressure, the latter conveys to the finger a sensation of flinty hardness. Transillumination shows darkness on the affected side, but the growth is seldom sufficiently circumscribed to endow this diagnostic resource with much value. An X-ray plate affords aid only within the same limitation.

Case of osteomalacia in a married woman, aged 35, who had been operated on fifteen years previously. The main orbital projection had been removed, with marked relief to the orbital symptoms. The patient consulted the writer because of severe pain, obstruction of the right nostril, and gradual protrusion of the right eyeball. The radiograph gave most valuable information as to the

position and extent of the exostosis. A curved incision was made from the middle of the right eyebrow to the right ala nasi. The expanded and thinned covering of bone was clipped off, and, the pedicle of the growth attached to the posterosuperior wall of the frontal sinus having been divided, the whole growth was removed with comparative ease by means of a strong pair of forceps. The growth measured $2\frac{1}{2}$ inches in length and $1\frac{1}{4}$ inches in breadth. The wound healed by first intention. Jones (Brit. Med. Jour., Nov. 17, 1906).

In examining the frontal sinus, antrum and ethmoidal cells, the writer takes first a lateral view of the face, and, secondly, an anteroposterior picture with the tube behind the head and the plate in front. Anteroposterior pictures of the head seldom show as well in print as in the original print or negative, which is best examined by transmitted light in a negative examining box. Tousey (N. Y. Med. Jour., Mar. 28, 1908).

Malignant Tumors.—Although all forms of malignant growths in this location have been recorded, *epithelioma* and *sarcoma* are those most frequently observed. The symptoms being practically those of chronic sinusitis, empyema, and mucocoele, an early diagnosis is difficult. Even the advanced signs, such as prominence of the eyeball with diplopia, amaurosis and pain, are common to other disorders. Suggestive, however, is a more or less foul discharge from the nose when it is streaked with blood and detritus, and traced with precision to the infundibulum, or, in the case of sarcoma, recurrent hemorrhages, traced to the same region. Swollen glands behind the angle of the jaw may suggest malignancy.

TREATMENT.—Mucocoeles and cysts can sometimes be opened in the

nasal cavity and its contents evacuated. This is facilitated by causing constriction of the surrounding tissues by means of a 4 per cent. solution of **cocaine**, followed by spraying with **saline solution**. In most cases, however, the contents are gelatinous and cannot be evacuated without an **incision** over the projecting wall, resecting a sufficient portion to allow **curetting** and **packing with iodoform gauze**.

Osteomata require **enucleation**; malignant growths likewise, if seen in time. Unfortunately, their progress is insidious and, as a rule, they are not recognized early enough to permit successful operative measures.

ETHMOID CELLS.

INFLAMMATORY DISORDERS.—The ethmoid cells may be the seat of *acute* and of *chronic* inflammation.

Acute Inflammation; Acute Ethmoiditis.—The proximity of the anterior ethmoidal cells to the frontal and maxillary sinus exposes them to involvement by contamination, while the posterior cells are exposed to it from the sphenoidal cells. Its connection with the nasal cavity exposes the ethmoidal sinus to the catarrhal disorders and to occlusion, nasal growths, swellings, etc. Being itself, besides, liable to inflammatory disorders, this sinus is probably more frequently diseased than is generally supposed, and the underlying seat of many stubborn cases of chronic rhinitis.

The symptoms of acute ethmoiditis are not always clearly defined. The pain is usually referred to the brow and behind the eyes, but sometimes only persistent headache is com-

plained of. The discharge of the anterior cells follows the same course as those of the antrum and frontal sinus, its elimination, anteriorly or posteriorly, if the nasal cavities are free, depending upon whether the head is bent forward or backward. Hence the fact that the nasopharynx often contains accumulated discharge in the morning after a night in the recumbent position. The acute form, which occurs as a complication of acute rhinitis or a temporary contamination from a neighboring inflammatory process, disappears when the latter ceases, unless imperfect drainage prevents it.

Chronic Inflammation or Chronic Ethmoiditis.—In this disorder the inflammatory process initiated by a similar process in the neighboring sinuses or the nose persists. In one form, the *hyperplastic*, the mucosa is swollen and gives rise to a watery discharge which is irritating to the nose, the alæ, and upper lip. There is severe boring pain either in the supraorbital region, suggesting neuralgia, or at the root of the nose, radiating toward the temples. There may be a sensation of pressure in the eyes, *muscæ volitantes*, and also *anosmia*. The pharynx, larynx, Eustachian tubes, and middle ear may be involved in the inflammatory process. Asthma is sometimes witnessed in these cases. Acute exacerbations are common, a feature which leads to atrophy of the muciparous glands, atrophy, and even sclerosis. The secretion may then become scanty and form a tenacious mass which dries and forms foul-smelling crusts.

The second form, *suppurative ethmoiditis*, differs from the former, in that the discharge is purulent instead

of merely watery. It may be caused by many morbid conditions: adjoining catarrhal disorders, imperfect drainage, syphilis, tuberculosis, erysipelas, influenza, and other infections, fractures, operative traumatism, etc. In most cases met with, however, obstruction of the outlet of the cells beneath the middle turbinate is a prominent cause. This may be due to the viscosity of the discharge, or, as is often the case, to mechanical obstruction in the middle turbinate or of the septum, either through osseous malformation or hypertrophy of their mucosa.

An important feature of this disorder is that, owing to the thinness of the partition walls, these break down easily and necrose, giving rise to a foul discharge. In a large proportion of cases there is merely a copious purulent outflow, voided through the nose or nasopharynx, the latter of which it reaches from the superior or middle meatus. The pus may be sanious, contain bits of necrosed tissues and other detritus, and give off a more or less offensive odor. Pain is rarely observed in the chronic form, but a sensation of marked dryness may cause considerable discomfort.

If retention of the pus in the cells occurs through obstruction of their lumina, serious symptoms may be developed, such as congestion, edema, bulging of and pressure in eyeballs, sometimes entailing diplopia and even blindness in neglected cases. Systemic disturbances, suggesting pyæmia, may occur. Mental disorders and meningitis may also supervene if the pus invades the cranial cavity—a not uncommon complication, which often proves rapidly fatal. Cerebral

abscess and thrombosis of the cavernous sinus, from infection of the ethmoidal veins, may also occur. Fortunately, the most usual result is rupture, with formation of a fistula leading externally to and opening below the brow, over the inner angle of the eye. The pus is thus eliminated externally.

The diagnosis of acute inflammation of the ethmoidal cells should be based upon careful examination of the nasal cavities. The above-described symptoms are all observed in inflammation of other disorders. Suggestive in this connection, however, is redness of the lower edge of the middle turbinate and extending beneath it. In the chronic form, a purulent discharge may be observed in this location coursing down along the external wall of the nose, and backward over the inclined surface of the inferior turbinate.

Latent sinusitis of the ethmoidal sinus may be the underlying cause of certain reflex neuroses. A simple operation on the sinus in such cases frees the patient from his "neurasthenia," "Ménière's disease," "hay fever," "nervous rhinorrhea" or other similar complaints. Henkes (*Nederl. Tijdsch. v. Geneesk.*, Apr. 12, 1919).

Treatment.—Acute inflammation of the ethmoidal cells is mainly perpetuated by obstruction of their outlet. The treatment recommended for acute inflammation of the frontal sinus in this section is also indicated here. In chronic inflammation the causative rhinitis, septal or turbinal malformation interfering with the drainage of the cells must be corrected. The measures indicated under CHRONIC RHINITIS (see page 72 in the seventh volume) will prove very efficient. Local applications of

a 20 per cent. solution of argyrol, after cleansing the nasal cavity, including the middle meatus, with warm saline solution is highly beneficial. This weak solution of argyrol may also be used with an atomizer provided with an upward tip, which may be passed under the middle turbinate. If a stronger solution (50 per cent.) is used, the applicator is preferable. Ichthiol and strong solutions of silver nitrate, which sometimes are necessary, should only be used with the applicator. The possibility of involvement of the neighboring sinuses should always be borne in mind and adequate treatment carried out if needed.

The antrum often acts as a reservoir for the pus originating in the ethmoidal or frontal cells, and hence efforts to cure an antrum abscess, without first curing the ethmoidal or frontal sinus abscess, prove futile, while, conversely, the curing of the latter will usually result in cure of the antrum disease without any attention being directed to the antrum itself. Todd (*Jour. Minn. State Med. Assoc.* and *N. W. Lancet*, Oct. 1, 1911).

When medication does not suffice, owing to obstruction offered by the middle turbinate to the drainage of the cells, the anterior portion, or in severe cases the whole turbinate, should be removed. By placing the diseased cells within reach of the remedies, and insuring efficient drainage and ventilation, this procedure often suffices. When this does not suffice, the ethmoid cells must be opened by means of Hajek's curved hook, and enlarged with Grünwald's forceps. Saline solution irrigations may then be used to wash out the cells, and a 10 per cent. argyrol spray to promote resolution, which often

occurs. If it does not, and necrosed bone be found, Bryan's ethmoid curette should be used to remove it while continuing the irrigations. Considerable care is necessary in this operative procedure to keep within the limits of the cells, as penetration of the cribriform plate above, or of the external cellular walls, may entail serious complications, and even death.

The writer reports 2 fatal cases of suppurative ethmoiditis in children, and concludes that there is an increasing conviction that acute suppurative ethmoiditis causing orbital and cerebral symptoms is not so rare a condition as has been thought, and that it is often rapidly fatal, especially in the young. The indications for operation in acute ethmoiditis are sudden increase in temperature, delirium at night, tumor formation in the inner wall of the orbit, the slightest exophthalmos. Operation should not be delayed too long. As in appendicitis, early operation is a harmless procedure, late operation generally useless.

When there is bilateral exophthalmos, operation is generally useless, as the disease has probably extended through the cavernous and circular sinuses, causing a general toxemia and pyemia, or fatal brain lesion. Krauss (*N. Y. Med. Jour.*, Apr. 24, 1909).

If it is the wish of the operator to clean out all the ethmoidal cells, the posterior half of the labyrinth is entered by piercing the attachment of the middle turbinate and by curetting still farther backward, using all the while the outer side of the middle turbinate as a guide. If the head of the patient is held level, the middle turbinate guides the curette backward into the posterior ethmoidal cell. Often the posterior half of the labyrinth is a large cavity, made up of only one or two cells. This portion of the labyrinth has been, as it

were, exenterated by nature. When the curette brings up against the back wall of the labyrinth the remaining part of the middle turbinate and the lower half of the superior turbinate are removed. Then the posterior part of the superior turbinate is taken away, flush with the front face of the sphenoidal sinus. The operator now recognizes the inner part of the front face of the sphenoidal sinus, which is free in the nasal cavity, and the outer part which has a common wall with the posterior ethmoidal cell. The posterior outer upper angle of the posterior ethmoidal cell is dangerous to curette or to probe. It is of the utmost importance that the operator should be sure of his landmarks in this locality. He orientates himself by finding the upper rim of the choana and then differentiating the free face of the sphenoidal sinus by proceeding upward from the rim of the choana close to the septum. Having made out the extent of the free face of the sinus, the width of the common wall between the sphenoidal sinus and the posterior ethmoidal cell is determined. The dividing line between the two parts of the anterior face of the sphenoidal sinus is made by the obliquely vertical line, which is the attachment of the superior turbinate.

The usual mistake made by the operator is to get lost in the posterior ethmoidal cell—that is, he goes too high and too far outward, and considers the posterior wall of the posterior ethmoidal cell as the whole of the front face of the sphenoidal sinus. This mistake, if persisted in, will carry him into the brain. Insufficient removal of the posterior part of the superior turbinate and allowing the head to become tipped upward, are the chief causes of this confusion. After the landmarks of the front face of the sphenoidal sinus have been cleared and recognized, the sinus is entered near the septum—if possible, through the ostium—and the whole of the anterior wall re-

moved. H. P. Mosher (Laryngoscope, Sept., 1913).

Non-operative treatment of infected sinuses, a suction apparatus being substituted, advised. The author has obtained entirely satisfactory results and has discarded operative work, except on the antrum. Illustrative reports of successfully treated cases include instances of severe acute frontal sinusitis; acute suppurative of the anterior ethmoid cells with orbital abscess; acute suppuration of the right frontal sinus; chronic suppuration of the frontal sinus, anterior ethmoid cells, and antrum; chronic suppuration of the left frontal sinus, and chronic suppuration of the posterior ethmoids and sphenoids. E. B. Gleason (Laryngoscope, 18, 1, 1918).

TUMORS OF THE ETHMOIDAL CELLS.

Benign Tumors.—*Mucocoele* of the ethmoidal, irrespective of involvement of the other sinuses, is occasionally met with. It may occur as a result of chronic ethmoiditis, especially when the ostium is occluded, or of blocking of some of the glandular acini. The tumor may fill the cell in which it is formed, break down the thin walls between the cells, or project out of the ostium and appear under the middle turbinate. *Myxoma*, *osteoma*, *fibroma*, and other benign growths may also occur in this location. All the growths develop insidiously, and cause no pain, until, in some instances, nerves are compressed, extended, or affected reflexly, or the neoplasm encroaches seriously upon neighboring structures and deforms them. In some cases other sinuses are penetrated by the growth which erodes the walls, separating them.

Case of a lady who had been annoyed for several months by a very profuse serous discharge from the

right nostril when she stooped. This discharge was found to escape from a small opening in the top of carious bone in the wall of the bulla ethmoidalis. The dividing walls of the ethmoid cells had all been destroyed, making one cavity of the lateral mass of the ethmoid bone. This cavity was lined by a thin, white, glistening membrane, the typical cyst lining in appearance. This membrane was cut-retted lightly, the cavity was packed for twenty-four hours to control hemorrhage, and then removed. A month later it was reported that the only change was that the discharge was now continuous, whereas formerly it had taken place only upon stooping. Inspection of the nose showed a free opening into the cyst with fully two-thirds of the cavity covered with normal membrane. Six weeks later the patient reported entirely well. Thompson (Laryngoscope, Mar., 1911).

Malignant Tumors.—*Sarcoma* and *epithelioma* of the ethmoidal cells is occasionally observed as a primary process. In epithelioma the growth may be very insidious and be discovered only when sufficiently advanced to cause nasal obstruction, when examination reveals its presence. A fetid discharge streaked with blood and detritus and enlargement of the glands behind the maxillary bone are suggestive. Sarcoma usually progresses more rapidly, and is apt to be attended with free and, sometimes, dangerous hemorrhages.

TREATMENT.—Surgical removal is alone of value. Malignant growths have often progressed sufficiently to involve many surrounding structures when first seen—a fact which greatly compromises the chances of recovery.

Case in a man, aged 55 years, who was unable to breathe through the right nasal passage, but without any other symptom of distress. The pas-

sage was found filled with cauliflower excrescences which bled at the slightest contact with the probe. Posterior rhinoscopy revealed pretty much the same aspect, and digital exploration detected a soft vegetative mass covering the rhinopharynx, the right choana, and reaching from the roof to the soft palate, barely passing the middle line, and consequently leaving a free space upon the right side. On diaphanoscopy, the frontal maxillary sinuses became illuminated normally. The mass was removed by external access with a good deal of hemorrhage, necessitating several tamponings. The middle and the superior turbinates were destroyed, the anterior ethmoidal cells resected to the cribriform plate of the ethmoid, and the septum was resected in its posterior portion. Every suspicious surface was thoroughly curetted, and hemorrhage arrested by tamponing the nasal fossæ with iodoform gauze, and the skin wound united with sutures. Recovery was good. Fifteen months later the patient still breathed freely, and his nasal fossa did not exhibit any trace of the growth. Audibert (*Revue Hebdomadaire de Laryngologie, d'Otologie et de Rhinologie*, Feb. 24, 1912).

SPHENOIDAL SINUS.

INFLAMMATORY DISORDERS.—The sphenoidal cells may be the seat of *acute* and of *chronic* inflammation.

Acute Inflammation.—Acute inflammation of the sphenoidal sinus may occur as an extension of a similar process in the neighboring sinus, or the nasal and nasopharyngeal cavities. It is identified with difficulty; the symptoms—a dull, deep-seated headache, referred by some patients to the occipital region, and by others to “somewhere behind the eyes”—constitute about all the subjective symptoms which suggest this disorder. Inspissated mucus, ac-

cumulated in the postnasal space, to the exclusion of the anterior nasal cavities, and voided, as a rule, is another suggestive fact. In some cases these symptoms persist and constitute a mild “postnasal catarrh.” In others, they disappear spontaneously.

Chronic inflammation or empyema of the sphenoidal sinus may be due to infection by neighboring purulent process in the other sinuses or nasal cavities, or syphilis, tuberculosis, or fractures of the base involving the sphenoid. Besides the symptoms observed in the acute form, neuralgia throughout the distribution of the fifth pair may be experienced, tinnitus and vertigo likewise. The discharge, instead of mucoid, is now mucopurulent and fetid, and tends to accumulate about the posterior end of the middle turbinate, and to pass down into the nasopharynx. When swallowed, especially if other sinuses are affected, which is often the case, gastric disturbances and nausea may be caused.

When obstruction of the sphenoidal orifice occurs, the symptoms increase greatly in severity, severe pain, insomnia, a febrile reaction occurring promptly. Extension of the inflammatory process to the brain is sometimes observed. As the distention increases, ocular phenomena appear, which may include congestion of the conjunctiva, swelling of the lids, and even amaurosis, owing to compression of the optic nerve. The swelling may block the posterior choane and cause violent aural symptoms. Rupture may occur into the ethmoidal cells, the orbit, or the skull, and cause, in the latter case, rapidly fatal meningitis.

The diagnosis of sphenoidal en-

pyema is based mainly upon the simultaneous presence of a persistent discharge into the posterior nares, traced above the vault area, and pain in the back of the head, after excluding the other sinuses.

The writer has devised an instrument which can be introduced into the pharynx by way of the mouth and which carries a miniature plate, so that this can be brought into contact with the wall of the sphenoid. By X-ray illumination through the frontal region of the cranium from above, an accurate picture can be obtained of the sphenoidal sinuses. The method is simple and yields valuable information regarding this region hitherto so difficult to photograph. Béla Freystadt (Berl. klin. Woch., July 13, 1914).

TREATMENT.—The treatment of inflammatory disorders is, in the main, similar to that of other sinuses reviewed. After applying a 10 per cent. solution of **cocaine** to the space between the middle turbinate and the septum, which will contract not only the tissues of these structures, but also those around the sphenoidal opening, a sphenoidal cannula is passed into the latter, and the cavity washed out with **saline solution**. Irrigation cannot be done sometimes without creating an opening in the most dependent portion of the sinus by means of a gouge passed along the surface of the middle turbinate, pointing the instrument upward and backward, under posterior rhinoscopy. Too big an opening by allowing the escape of a large quantity of pus to escape may cause syncope, hence a small opening is preferable at first. The **curette** is sometimes necessary, followed by **saline solution** irrigations and the local application of a 10 per cent. solution of **argyrol**.

Although it is not necessary to have the ostium in view in passing a sound, to the author's mind it is absolutely demanded when operative measures are about to be undertaken; the anatomic relations of the superior wall to the optic nerve and the pituitary body and the lateral walls to the sinus cavernosus and carotid artery, to say nothing of the brain itself, makes this region of operating one of extreme danger, unless the operator has perfect vision of the entire field. The lateral wall of the nose, as well as the septum, is **cocainized** with a 20 per cent. solution, the posterior half of the middle turbinate is removed, the posterior ethmoid cells are broken through with Hajek's ethmoid hook, and the *débris* removed with a Grünwald-Hartmann conchotome or a similar instrument. The evulsor is then inserted in the ostium and the opening enlarged by a few well-directed pulls; this is followed by the use of the bent forceps of Hajek and enough bone is removed as to insure a permanent opening, which should reach as far as the floor of the nose. Complete healing usually takes place in from three to eight weeks, depending on the degree of inflammation and the extent of the operative interference. The advantages of this operation is that a full field is always in sight; the preliminary opening of the sphenoid from within outward thereby incurs no danger to the structures behind; and there is a permanent opening which lessens the danger of recurrence. Ross H. Skilern (Jour. Amer. Med. Assoc., Dec. 19, 1908).

The writer anesthetizes the nose with **cocaine** and **epinephrin**, and punctures the anterior wall of the sinus at its lower and internal portion. In the absence of any obstructive deformity of the upper part of the septum nasi this can be readily accomplished in the vast majority of cases, and no removal of nasal tissue is necessary. This opening has the

further advantage of being in the best position for drainage of the cavity. The operation is free alike from pain, hemorrhage, and danger. If the cavity is normal the wound will have closed in twenty-four hours. If the sinus is infected the operation affords the best possible opportunity for making an early and accurate diagnosis and for the employment of suitable measures for local treatment, particularly lavage and drainage. C. P. Grayson (Penna. Med. Jour., Apr., 1913).

TUMORS OF THE SPHENOIDAL SINUS.

Benign Tumors.—*Myxomata* and *osteomata*, occasionally found in this sinus, are harmful mainly because they tend early to produce obstruction, and, therefore, bring on empyema. As the tumor grows it brings on pressure symptoms, blindness or optic neuritis, when the optic nerve is compressed; exophthalmos of the eyeball, etc.

Malignant Growths.—These produce phenomena similar to those just described when they have progressed sufficiently to do so. A purulent sanguinolent discharge in the vault, traced upward to the sphenoidal opening, is about the only early sign available.

TREATMENT.—The location of the sphenoid renders operative removal impracticable, especially in view of the fact that the cases are usually far advanced when they reach the specialist.

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SKIN-GRAFTING.—When skin-grafts are obtained from the patient himself, they are called *autografts*; when from another person, *homografts*; and when from animals, *soö-*

grafts. The best results are derived from autografts. Homografts grow better than zoögrafts, but it must not be forgotten that they may cause disease, especially syphilis, and that they may break down and disappear upon slight provocation.

Reverdin's Method.—With fresh wounds or healthy granulating surfaces little preparation is necessary. Freedom from suppuration would, of course, be desirable, but it is seldom attainable. When the granulations are not in good condition an effort should be made to render them firm, red and healthy by pressure, by repeated cauterization with stick nitrate of silver, or by painting them occasionally with tincture of iodine. Leg ulcers may often be much improved by elevation of the extremity. Callos ulcers should have radiating incisions made in their borders. Foul ulcers must receive preliminary antiseptic treatment, and all sloughs should be cleared away before grafting is attempted.

The grafts, which are best obtained from the arm or thigh, should be about the size of a grain of wheat. They are cut by elevating a portion of skin with mouse-toothed forceps and dividing it with scissors curved on the flat, removing the entire epithelium and a portion of the corium without disturbing the subcutaneous fat. The bits of cuticle adhere to the surface to be grafted, especially if gentle pressure with a pledget of gauze be employed. Nothing is gained by scraping or in any way wounding the granulations. The transplantations should be close together, as the greatest size to which a graft can grow is perhaps that of a silver dime. Excellent grafts can

be cut with sharp-pointed scissors from the delicate pellicle of new skin which pushes out from the borders of a healing ulcer (Souchon). Immediately over the grafts may be placed strips of rubber protective, or a single layer of gauze, which may be pinned around a limb or fastened at the edges with collodion. Whether the external dressing is moist or dry is usually of little importance, but no antiseptic stronger than boric acid should be used. As there is generally some suppuration, it is necessary to change the superficial portion of the dressing every twenty-four hours at least, leaving in place the rubber tissue, or the undermost layer of gauze, as the case may be. Gentle irrigation with a solution of salt or boric acid assists in maintaining cleanliness. The **open method of dressing** has recently come into use, and may often be employed to advantage. In this the grafts are left entirely uncovered, being protected from injury by placing over them a "cage" made of wire gauze (a kitchen "strainer" for instance). The edges of the gauze are bound with adhesive plaster, a few strips of which may be utilized to hold the cage in position.

Thiersch's Method.—There is no process of skin-grafting so simple, so reliable, and so generally applicable as this. It is of great value in the treatment of ulcers, burns, and defects following operations or injuries.

The patient is anesthetized, and if granulations are present, it is best to scrape them away with a sharp spoon down to the comparatively firm tissue beneath, although this is not absolutely necessary. Oozing is checked by elevation and pressure, an Es-march strap being unnecessary. The

grafts are cut with a razor from the anterior surface of the thigh or upper arm. An assistant makes the skin tense by means of a hand on either side of the limb, while the operator, standing with his back toward the patient's feet, cuts toward himself, with his left hand stretching the tissues in the direction of the knee. With a backward and forward sawing motion it is not difficult to obtain shavings of epidermis an inch or more wide and several inches in length, and as thin as paper. No objectionable scar results. The delicate strips of cuticle fold up on the blade of the razor, from which they may be spread directly upon the surface to be grafted, and so adjusted that they overlap each other and the edges of the skin, completely concealing the raw surface. Healing without suppuration is not uncommon. Over the transplanted cuticle are placed strips of rubber tissue, a single layer of gauze, or simply a wire cage as described in the Reverdin method. Davis uses a coarse-meshed net, such as is used for curtains, for "splinting" the grafts in position. The stiffening is washed out and the net is soaked in gutta-percha 30 parts, chloroform 150 parts, and is sterilized by keeping in a 1:1000 solution of mercury bichloride. If a moist dressing is employed, it should consist of a thick pad of gauze saturated with normal salt solution and covered with cotton and oiled silk. This should be renewed often enough to keep it moist. A dry dressing answers equally well, applied as in the treatment of ordinary wounds. The grafts do not become firmly fixed for nine or ten days, and it is well not to soak off the under-

most layer of gauze for about two weeks.

The Wolfe-Krause Method.—In this method grafts are employed which fill the entire defect, and which comprise the whole thickness of skin without the subcutaneous tissues. The fat may also be included if desired, although the chance of success is less (Hirschberg). In cutting the skin at least one-third must be allowed for shrinkage. Sutures are usually unnecessary and artificial heat is detrimental.

Wolfe's original method has been modified and the technique improved by Krause, who employs spindle-shaped grafts, so that the wound produced by their removal may be sutured immediately. The pieces of skin, cut into smaller pieces, if desirable, are accurately fitted into the defect which is to be closed. The operation must be a "dry" one, and the raw surfaces of the skin should be handled as little as possible.

Skin-periosteum-bone grafts are sometimes employed. They are cut out bodily, from the tibial region, for instance, without disturbing the connections of the component parts to each other.

Two curious methods of skin-grafting introduced by MacLennan should be mentioned, although they are seldom employed. They are known as "tunnel grafting" and "caterpillar grafting."

In **tunnel grafting** small grafts are slipped beneath the granulations into little "tunnels" made for the purpose, where they are surrounded by blood-clot and protected from external injury, which is supposed to facilitate their growth under certain conditions, especially where the granular surface

is unfavorable for their existence. In five to seven days the granulations are cut from above and the grafts exposed.

In **caterpillar grafting**, which really belongs to plastic surgery rather than to skin-grafting, a long, narrow, full-thickness flap (about 1 inch by 5 inches) is dissected up from the adjacent integument with its base close to the area to be grafted. The distal extremity is then stitched close to the base, thus humping the flap up in its center, much as a caterpillar crawls. After union of the tip has taken place in this position, the base is loosened and the flap straightened out upon the granulating surface. The occasions are not numerous, however, in which this "crawling" procedure is preferable to free grafting.

Subcutaneous Skin-grafting.—Under ordinary circumstances skin-grafts cannot be used beneath the surface of the body owing to the danger of infection. Rehn has demonstrated, however, that this can be done with more or less success by shaving off the superficial portion of the transplant, thus mechanically removing the bacteria. Grafts of this character have been employed as a substitute for lost tendons, to close the pylorus, etc., but it would seem that less complicated methods are preferable, such as the use of fascia lata.

Anomalies in Grafting.—Transplantation of the **mucous membrane** may be made. It may be shaved off as in skin-grafting,—for instance, from the lips,—or it may be stripped off in its entirety.

More or less satisfactory results can be obtained by the use of **shavings of callus** from the palms of the

hands or soles of the feet, or from sections of corns. "**Epithelial rods**" from warts have been successfully used, as have also flakes of old, dried epidermis from various parts of the body; even "**epithelial dust**" scraped from the surface of the skin will often grow on a granulating wound. Deeper scrapings, drawing sufficient blood to form a paste which may be spread upon a raw surface, are said to be quite satisfactory at times (Mangoldt).

Grafting from dead bodies or from amputated limbs has frequently been resorted to, but the chance of success is not great, and the danger of carrying disease cannot be disregarded.

Sponge-grafting is now seldom employed. Very thin slices of sponge are sterilized by boiling, and placed upon the raw surface. The material acts as a framework only for the granulations, and is soon absorbed.

The idea of **grafting from animals** is attractive, but the results are too uncertain, and the method has largely fallen into disuse. Skin has been obtained from frogs (abdomen), chickens (beneath the wings), pigs, dogs, cats, rabbits, guinea-pigs, etc. Cocks' wattles, sections of the testicles of rabbits, amniotic membrane, and the lining membrane of eggs have also been employed.

HISTOLOGY AND PATHOLOGY.—The existence of epithelial grafts may be said to be, for a time, parasitic. In the course of about eighteen hours vascular connections begin to form, firm adherence taking place by the tenth day. Successful grafts soon become pinkish in color. New skin arising from large grafts, which cover the entire raw surface (Thiersch and Wolfe grafts), be-

comes in time movable, but that produced from Reverdin grafts remains immovable, owing to cicatricial tissue between the individual bits of cuticle. Hairs may remain where transplantations of the entire thickness of the skin are made, but they are apt to become deformed or fall out. But little postoperative contraction takes place in the Thiersch and Wolfe-Krause methods, but in the method of Reverdin contraction is apt to be considerable. Exfoliation of epidermis may occur in any form of grafting, but this does not necessarily mean that the grafts are dead. A remarkable phenomenon in connection with Thiersch grafting is the readiness with which depressions fill up to a level with the surrounding skin.

In plastic work about the face it should always be borne in mind that flaps of skin from the vicinity, for instance from the neck, are preferable to free grafts, especially the thinner ones, because their color and consistency will conform more nearly to that of their surroundings, thus rendering them far less conspicuous.

COMPARISON OF METHODS.

—The simplest is that of Reverdin, although the new skin is often little better than scar-tissue. It should be reserved for cases where the rapid closure of a granulating surface is desired without reference to anything else. Thiersch grafting has a wider range of applicability than any other method, and its results are uniformly good, both functionally and cosmetically; but it must give way to the Wolfe-Krause process when thicker skin is desired, which more closely resembles the surrounding integument. It may sometimes be expedi-

ent to graft from dead bodies or from amputated limbs; and occasionally use may be found for "epidermal scrapings," or for epidermis obtained from warts, corns, callosities, blisters, etc., but one must not expect the results to be brilliant.

The skin of animals does not compare in vitality with that taken from a patient's own body, or even from some other person. It is seldom necessary to transplant from mucous membrane, as ordinary Thiersch grafting answers the same purpose in nearly all cases.

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SKIN, SURGICAL DISEASES OF.—SEBACEOUS CYSTS, or WENS.

—A wen (steatoma) is a cystic tumor varying in size from a millet seed to an orange, formed by the retention of secretion in a sebaceous gland, and situated in the skin or subcutaneous structures. Wens occur most frequently on the scalp, face, back, and scrotum, and may be single or multiple. The contents of these tumors are milky or cheesy in character, but if the tumor be injured, inflammation and ulceration may follow, or in the aged the tumor may acquire a malignant character, degenerating into epithelioma.

Treatment.—A cure will be effected by making an **incision** in the skin down to the cyst and carefully **dissecting it out**. Incision and mere evacuation of the contents are always followed by a return of the tumor.

FURUNCLE.—Furuncle (furunculus; boil) is a local inflammatory affection of the skin, commonly involving a cutaneous gland or hair-follicle. They may be single or multiple, and may appear in "crops."

The **diagnosis** of the affection is usually quite easy. It may sometimes be confounded with carbuncle. General appearance, single opening, and circumscribed character usually distinguish the boil.

Etiology.—Improper diet and hygiene, nervous depression, overwork, too free indulgence in greasy foods and gravies, and irregular action of the bowels, local irritation, friction, and prolonged poulticing predispose to this affection. The entrance of pus-cocci into the skin is the essential or exciting cause of this disorder. Single boils are usually the result of local irritation; their appearance in successive crops (furunculosis) is usually an indication of impaired health.

Treatment.—Removal of the cause and regulation of the diet claim first attention. **Open-air exercise** and **tonics** are useful in debilitated subjects. **Strong ammonia**, **caustic potash**, **acid mercury nitrate**, and other forms of caustic have been used to abort in the early stage. **Yeast**, **nuclein**, **quinine**, and **mineral acids** have been given to prevent recurrence. **Arsenic**, with or without **iron**, is sometimes beneficial. **Sodium sulphite** or **thiosulphate** (15 to 30 grains—1 to 2 Gm.—every three hours), **calc sulphurata** ($\frac{1}{8}$ grain—0.008 Gm.—every two or three hours), or **sulphur** may be given internally. A solution of **boric acid** or of **sublimite**, a 10 per cent. **salicylic acid ointment**, or a mixture of equal parts of **ichthyol** and **collodion** may be applied locally. White has used full doses of **mercury bichloride** internally to prevent recurrence.

Hypodermic antiseptic injections into the very base of a boil or carbuncle, early in its history, are practically an unfailing means for aborting an attack.

Heat is directly injurious to the microbes of furunculosis; active hyperemia is induced, and the skin sterilized; the profuse sweating induced prevents rapid increase of temperature in the deeper tissues. The **hot air** is first applied around the circumference of the affected part, and then to the boil itself. Two or three applications are given on the first day, and one daily afterward. Temperature of air, 250° F. (120° C.).

CARBUNCLE.—**Definition.**—Carbuncle (carbunculus; it is erroneously called benignant anthrax, or anthrax) is a hard, circumscribed, deep-seated, painful inflammation of the subcutaneous tissue, accompanied by chill, fever, and constitutional disturbance, and attended almost

always with circumscribed suppuration and the formation of a slough.

Symptoms.—The local symptoms are heat and aching, with throbbing and great tenderness, which are often followed by pain and redness along the lymphatics of the part and pain and swelling in the nearest lymphatic glands. There is at first a chill, followed by a febrile movement, which is generally well marked, and often very severe. The constitutional symptoms resemble those of erysipelas very closely, and may be as severe as those of the severest forms of that disease, and the consequences may be fully as grave and fatal.

Diagnosis.—The size of the inflamed area, flatness of surface, multiple openings or points of suppuration and extensive slough differentiate carbuncle from furuncle. Carbuncle is single, furuncle generally multiple.

Etiology.—A lowered vitality from any cause predisposes to this affection. It is especially common in diabetes. Microbic infection is the exciting cause.

Prognosis.—Carbuncle is especially dangerous when located on the scalp, abdomen, and upper lip; in these locations it is apt to occur in young people, and usually runs an acute course and, as a rule, is fatal from pyemia. The prognosis is grave when extensive and attacking the elderly, especially if complicated with Bright's disease or diabetes. The prognosis should always be guarded, even in the most hopeful cases. Death is not infrequent in the old and debilitated.

Treatment.—General tonics, like quinine and iron, with large amounts of nourishing food, are indicated. Opium or other anodynes may be required to relieve pain and procure rest. Stimulants should be given only when required.

Reynolds advises dilute sulphuric acid in 20- to 30-minim (1.3 to 2 c.c.) doses in 2 ounces (60 c.c.) of water every four hours (small doses are useless), with 5 per cent. carbolyzed petrolatum locally.

In the early stage 10 to 20 minims (0.6 to 1.3 c.c.) of a 5 or 10 per cent. solution of phenol in glycerin may be injected into the central portion of the mass with the view of aborting the mischief. If seen later, firm compression by straps

of adhesive plaster applied concentrically may be made, leaving the central orifice free for the discharge of sloughs and applying an antiseptic dressing over the straps.

Another plan, applicable in the early or late stage as well: Place patient under an anesthetic; freeze the parts to make them friable; make one long incision or several crucial incisions through the mass; remove all sloughs and decaying tissue with a sharp curette; disinfect, drain, and suture, as in an incised wound.

Another method of treatment is the application of warm, moist, antiseptic dressings, covered with thin rubber cloth or oiled silk, removing sloughs as soon as loosened, and using iodoform, aristol, euophen, or similar antiseptic powder freely. The use of poultices is harmful and should be avoided.

The use of autogenous vaccine, once a week in dose of 100 to 200 million dead cocci was effectual. Bier's passive hyperemia by means of band around lower part of the neck was used with success in carbuncles of the face and high up on neck. Mild constriction was sufficient for twenty to twenty-two hours daily unless edema appeared.

Ichthylol is practically a specific in the treatment of carbuncles, applied pure, so as to cover the entire swelling, except the apex. The apex on which the ichthylol is absent is covered with a piece of cloth greased with tallow. The application is renewed once a day. After three applications the surface should be washed thoroughly so as to remove the varnish-like coating which the ichthylol forms on drying, and a new application is to be made.

Personal experience in the local treatment of carbuncle with liquid air has shown A. Campbell White that this is by far the best form of treatment. It is less painful to the patient than any other form of treatment. Only one application is necessary. In the treatment by liquid air the spray is used, first projecting it into the openings and using the air quite freely; then quite thoroughly freezing the external surface, which must be well cleansed of discharge resulting from sending air inside the carbuncle before

freezing. After freezing the carbuncle should be dressed with a dry absorbent dressing. The reaction from freezing takes place in about twenty minutes, and it is to this extreme hyperemia that the success of liquid air in the treatment of this affection is attributed more particularly.

KERATOSIS SENILIS.—This affection is a cornification of the skin of old people, general or partial, circumscribed or diffuse, and often limited to the face and the dorsal surfaces of the hands and feet, or sometimes the forearm and chest. The lesions consist of light- or dark-yellow, brownish points, dry scaling and horny, or scaling and greasy, aggregated masses of an irregular circular or oval outline. The surface of these masses is insensitive, and may project about an eighth of an inch above the surface. These masses may be readily picked off, leaving a small, superficial, smooth, excoriated surface or one covered with minute conical elevations (enlarged sebaceous glands). This affection rarely appears before the fiftieth year, and may not claim attention until fifteen or twenty years later.

Prognosis.—The prognosis is favorable if the proper treatment is promptly applied. When left alone the pigmented masses are prone to epitheliomatous degeneration, and may become foci for carcinoma of the face, in which case the dry scales are displaced by a scab, the tissues become hard, and growth is more rapid.

Treatment.—In the early stage, incisions with **petrolatum** or **olive oil** and the subsequent use of **soap and warm water** will remove the trouble. When the masses are firmer, **ointments** should be applied at night, and **soft soap** or **sapo viridis** in the morning, removing the soap by carefully washing with clean, warm water; applications of **diachylon ointment** will heal any excoriations that may have been produced. When marked projection of the mass is present, the thorough use of the **curette**, or **nitric acid** on a pointed stick, well worked into the parts, will remove the affected tissues. If epitheliomatous change is suspected, prompt excision is indicated.

CLAVUS (CORN).—Clavus is an hyperplasia of the corneous or horny layer of the epidermis, in which there is an ingrowth as well as an outgrowth of horny substance, forming circumscribed epidermal thickenings, chiefly about the toes. Corns may be hard or soft, the latter being situated between the toes, where they become softened by maceration. Both forms are caused by intermittent pressure and friction. Pressure produces pain by driving the conical mass of hardened epithelium down upon the sensitive corium; constant irritation may produce inflammation and suppuration.

Treatment.—The use of **well-fitting, comfortable shoes** made on properly shaped lasts is the first indication. Temporary relief from **hard corns** may be obtained by the use of **felt rings** which are applied over the corns, allowing the latter to project through the opening. Prolonged soaking in a **warm solution of sodium carbonate** will soften the corn, when it may be removed by gentle **scraping** with a sharp knife; the tender surface left may be protected by covering it with a plaster of **salicylic acid** or of **salicylic acid with cannabis indica**. Another method is that of hardening the surface of the corn by applications of the **tincture of iodine** or **silver nitrate** at night, removing the hardened tissue on the following morning. A third method is the use of the **salicylic-collodion mixture**: **Salicylic acid**, 30 grains (2 Gm.); **tincture of iodine**, 10 minims (0.6 c.c.); **extract of cannabis indica**, 10 grains (0.6 Gm.); **collodion**, 4 drams (15 c.c.); this to be painted on the corn night and morning for several days and then removed with the corn, by **soaking in hot water**. **Soft corns** are best treated by gentle **scraping** to remove the softened epithelium, the surface being then protected by a **pad of natural wool** (as it is clipped from the sheep), or of absorbent cotton, having previously dusted the surface with a powder composed of equal parts of **zinc oxide** and **boric acid**. When corns become inflamed, **rest and warm, moist, antiseptic dressings** meet the indications. If pus has formed it must be afforded an exit and the wound treated with antiseptics, **iodoform**, **anatomol** or **europhen**.

Corns should never be cut too closely, as cruris and gangrene may follow, especially in the aged.

VERRUCÆ.—Verrucæ (condylomata; warts) are circumscribed papillary excrescences on the skin, variable in color, smooth at the summit, or studded with moniliform elevations or with clusters of minute, pointed, horny filaments. They may be single or multiple, hard or soft, rounded, flattened or acuminate. They may rapidly attain their full size, may last indefinitely (*l. persans*), or spontaneously disappear, at any stage, and are not contagious. If picked or wounded, warts bleed freely, being often very vascular. The etiology of warts is obscure.

Treatment.—The milder applications consist of the juice of the milk-weed (*Asclepias cornuti seu Syriaca*), the tincture of iodine, the solution of iron perchloride, moistened powder of ammonium chloride; stronger applications are sublimate colloidion (30 grains to the fluidram), glacial acetic acid (best of acids, as it leaves no scar), chromic acid and fuming nitric (nitroso-nitric) acid. Excision (warts on the face should never be cauterized, but excised) or curettage if the warts be soft, is the quickest method of removal; the hypodermic injection of cocaine will lessen or prevent the pain, and the application of fuming nitric acid to the stump or base will restrain the hemorrhage and prevent return. A 10 per cent. salicylic acid or resorcin ointment is slow but effectual. Electrolysis is efficient but painful, for large warts. Ethyl chloride spray, liquid air, and carbon dioxide snow are efficient. Quicklime rubbed on the hands and washed off in an hour is effective when warts are numerous; this should be done twice daily and continued for a fortnight. Intravenous injections of salvarsan and neosalvarsan have been used successfully when warts were numerous.

The internal use of ½ pint (250 c.c.) of lime-water daily for a week (Kennard) and 1 dram (4 Gm.) doses of Epsom salt thrice daily (Ridley) have given satisfactory results.

Instead of cutting or the use of caustics, Purdon uses an India-rubber finger-stall,

if the warts are on the fingers, or an India-rubber bandage, if they are on the hands. The rubber exerts gentle pressure, while the wart is kept moist and macerated from retained perspiration.

Venerical warts may be washed well with bichloride or other antiseptic solution, and then dusted with iodoform, calomel, aristol, or euophen.

HYPERTROPHIED SCARS.—When a wound is completely healed, a cicatrix or scar occupies its place. Normally, two things are observed in a scar: its contraction and the gradual perfecting of its tissues. The principal changes by which the latter is accomplished are the removal of all the rudimental textures; the formation of elastic tissue; the improvement of fibrous or fibrocellular tissue of the new cuticle till they are almost, but not exactly, like those of natural formation; and the gradual loosening of the scar, so that it may move easily upon the subjacent tissues.

Treatment.—Hypertrophied scars may be treated by multiple incisions and thiosinamine. Tubby uses a fine and strong-backed tenotomy knife and makes a large number of incisions in the scar tissue, transversely to the long axis of the scar, not more than ⅓ inch apart, and extending both into the subcutaneous fat and for about ½ inch into the adjacent healthy skin. Hemorrhage is stopped by pressure alone, and then a solution of thiosinamine is thoroughly rubbed in. From 15 to 20 minims (1 to 1.3 c.c.) of the solution may be injected at one time in an adult. After injection the part is splinted in extreme extension.

Fibrolysin plaster applied to the scar and left for fourteen days, gave excellent results.

Excision of the scar and repair by plastic operation is applicable in some cases. See also page 176.

KELOID.—Keloid (cheloid; kelis; Alibert's keloid; spurious keloid) is a new growth of connective-tissue formation having its seat or origin in scar tissue and resulting in the formation of single or multiple tumors.

Symptoms.—It first appears as a pale-red nodule which slowly increases in size, assuming a more or less oval form, with

irregular, well-defined, radiating projections. From its resemblance to a crab it derives its name. It may more rarely assume a linear form. The new growth is smooth, firm, elastic, pinkish, elevated, generally devoid of hair, usually painless, but sometimes tender when touched or subjected to pressure; and is occasionally the seat of the most intolerable itching, which no external application seems to relieve. The favorite location of this growth is over the sternum, but it may be situated on the mammae, the neck, arms, and ears. In rare instances the growth may become inflamed and assume for a while the appearance of malignancy, which appearance disappears usually with the spontaneous decline of the inflammatory action. The development of the growth may be slow or rapid, until a stationary period is reached, which varies in duration. Spontaneous disappearance of the growth not infrequently occurs. In some cases the growth becomes painful, in others a pigmentary deposit is noticed. This condition was first described by Alibert, and is known as spurious keloid to distinguish it from true keloid, which does not attack scars (Erichsen).

Diagnosis.—*Alibert's keloid* is differentiated from a simple cicatrix by its difference in consistence, outline, color, and elevation, and by its increase in size. Its points of difference from hypertrophied scars have been mentioned.

Etiology and Pathology.—These new growths have their origin at the seat of some injury (sometimes very slight) to the skin, as the cicatrices of burns, floggings, cuts, or in the lobes of the ears when they have been pierced for the accommodation of earrings. They are most frequent in middle life and in the colored race. The growth consists of dense fibrous tissue, which involves the corium and extends in the direction of the connective tissue about the blood-vessels.

Prognosis.—The prognosis is not generally very favorable, although the growths may sometimes disappear spontaneously. The stationary period may extend over years or during life. Occasionally, after a stationary period of variable duration, an increase in size takes place.

Treatment.—The treatment of these new growths is not very satisfactory. The application of **anodyne liniments** or hypodermic injections of **morphine** will generally relieve pain when present. The administration of large doses of **liquor potassæ** will often relieve the pruritus. **Removal by knife** or **caustics** should not be attempted while the growth is increasing. **Fused caustic potash** is recommended as best, if any caustic is used. Multiple **electrolytic puncture** and repeated **scarification**, making numerous parallel linear cuts crossed at various angles by other parallel linear cuts, have been suggested with the idea of replacing the diseased scar by a healthy one.

Sodium salicylate taken internally (20 to 30 grains—1.3 to 2 Gm.—three or four times daily) has a marked effect in the resolution and absorption of keloid. Injections of **fibrolysin** (35 minims—2.3 c.c.) made daily or even once a week has caused the disappearance of keloid.

Radium has proven highly effectual both for keloids, excessive scarring, and deep fibrous adhesions. All cases of keloid reported on by F. C. Harrison (1918) showed disappearance or marked improvement under radium. Well exposed keloid to very hard **X-rays**. Lesieur reported satisfactory results in 100 cases from injections of **creosote** in sterile **olive oil**, 1:15; 2 drops to 80 minims (5 c.c.) are injected *under* the keloid at each sitting.

MALIGNANT DEGENERATION OF SCARS.—The cicatrix of a burn or other extensive scar may undergo malignant degeneration many years after its formation. Erichsen removed a large canceroid growth from a cicatrix of a burn, on the forearm of a woman, seventy years after the receipt of the injury, which happened in childhood.

BURNS.

DEFINITION.—A burn is a high grade of acute inflammation, following the direct or indirect application of dry or moist heat to a portion of the cutaneous or mucous surfaces.

VARIETIES.—For ease of comprehension burns have been separated into grades according to their severity.

A temperature, slightly increased above the normal (as, for instance, 100° F.—

37.8° C.), produces only a slight hyperemia (first degree: dermatitis ambustionis erythematosa), which may disappear shortly after breaking the contact, while a rise of 150° F. (65.6° C.) will cause some appearance of vesicles and bullæ (second degree: dermatitis ambustionis vesiculosa et bullosa) and destruction of the epidermis, the effect of which is not relieved for days after the removal of the burning substance, and yet, on the other hand, heat at the boiling point of water (212° F.—100° C.) may cause a complete carbonization of the part, resulting in the formation of eschars varying in color from a yellow up to a dark brown or black or, in other words, the production of gangrene (third degree: dermatitis ambustionis escharotica seu gangrænosa).

SYMPTOMS.—The effects of a burn upon the body structure are both local and constitutional. The former often results in great disfiguration or destruction of tissue, while the latter depresses the vital forces or terminates in death.

Local Effects.—In burns of the *first degree* the appearances produced are superficial. There will be observed a distinct hyperemia with redness of varying intensity from the slightest blush up to a pinkish red or brownish red. This may or may not be entirely effaced by pressure. This type of burn is produced by indirect contact with the flame of a lighted match, proximity to a heated metal, escaping steam, and the actinic rays of the sun. With or without treatment the effect of burning to this extent may disappear shortly after removing the exciting cause.

In burns of the *second degree* the inflammation, while yet superficial, may still occupy the entire epidermis. In some cases the upper layers alone of the cuticle may be destroyed, while vesicles or bullæ may be observed over the affected surface. In still other cases the corium is stripped entirely of its epidermal covering or particles of the membrane may be rolled into whitish masses over its exposed surface. These vesicles or bullæ may be produced directly by the contact of the heated article or indirectly by the consequent inflammation. They

may retain their contents or, owing to the increased flow of serum, their walls, becoming thin and losing their elasticity, rupture, thus allowing the escape of a continual discharge over the denuded surface. The true skin, which is exposed either entirely or at points, shows a highly reddened surface, over which this continual exudation may be observed. In this type of condition actual contact with the heated substance takes place either in shorter or longer durations. Such articles as heated iron, transient or lengthened action of flames, and boiling liquids may be the exciting agent. The effects of this form of burn do not always show to what extent they have progressed immediately upon the removal of the cause, because of the systemic conditions which may be induced. Pain is always present to a minor or major degree.

Resolution takes place through coagulation of the serous discharge, which occupies the involved area as a fibro-aluminous covering beneath which the new skin is allowed to form.

In the burns of the *third degree* the inflammation or destruction may be superficial, extending over considerable area, or deep, affecting the subcutaneous tissues, muscles, and even bones.

Resolution takes place in the uncovered variety in the same manner as described under the foregoing degree, while in the covered variety granulations spring up beneath the charred remains which, after a time, desiccate and fall off, exposing a similar surface to that of the second degree.

In the deeper form of burn the extent of surface involved may be small or large, but may dip down to varying depths. The amount of charring will usually be very great and will lie about in masses over the burned surface, thus preventing a view of the destruction beneath. Resolution even in the milder cases is slow, and before such happens surgical interference may be demanded. The cause which brings about this form of burning is usually dry heat (flames or contact with electric wires); it entails much greater destruction than will moist heat. The effect upon the system is

alarming, and shock may carry off the person before relief can even be attempted.

Electric and X-ray Burns.—Burns from electricity may be observed in all the varieties mentioned above. They may follow direct or indirect contact. Examples of direct contact are observed after handling live (charged) wires, and may be found to destroy all parts with which it comes into touch, or life even may be the forfeit. Such burns resemble moist gangrene or severe frost-bite. The pain is often very severe and the healing process is much slower than in the case of ordinary burns.

A most recent form of burning of the skin from the indirect contact of electricity is by the X-ray apparatus. Close proximity to the ray by either covered or uncovered parts result either in a superficial or deep inflammation of the skin. It may be observed a few hours after exposure to the rays or may be delayed for several weeks. This form of burning attacks the skin alone in some instances, while in others the deeper structures, as the muscles, tendons, nerves, and bones (periostitis and osteitis resulting) are involved. The effects may remain for days, weeks, or even months after the application. The X-ray burns are supposed by some to be produced by the action of the ray or by particles of aluminium or platinum reaching and being deposited in the tissues by others, and by others to be the result of an interference with the nutrition of the part by the induced static charges.

The patient may be absolutely protected from the harmful effects of this static charge by the interposition between the tube and the patient of a grounded sheet of conducting material that is readily penetrable by the X-ray, a **thin sheet of aluminium or gold-leaf** spread upon cardboard making an effectual protective shield.

Burns of Mucous Surfaces.—The mucous surfaces may be affected by the inhalation of flames, vapors (volatile or boiling acids), boiling liquids (water, slacked lime), and by certain substances acting directly, such as ammonia and sulphuric and hydrochloric acids. The mouth, pharynx, larynx, bronchi, and

the esophagus, as well as the stomach, share in the attack. The eye often, from its exposed position, is the seat of burn. Conjunctivitis often results from irritants coming into direct contact with the eye, and if the exciting agent is not soon removed great destruction of substance or sight may be the result.

Constitutional Effects.—The effects of burns of the first degree upon the system are generally slight and are limited to pain which disappears shortly after the removal of the exciting agent, but often may last for several hours.

In burns of the second degree the pain accompanies the phenomena not alone for hours and days, but often for weeks and even months. The shock may be of a transient character or of an alarming intensity. It may be encountered at the time of accident or be delayed for periods varying from hours to days thereafter. When small areas are involved, the depression may soon be relieved, but when one-fourth or one-third of the body is attacked death may intervene.

Burns of the third degree may be so severe that death intervenes before pain has time to appear. Shock at this stage is therefore observed early and of the worst character. Early mortality is generally due to the shock, while late mortality usually occurs during the stage of suppuration. Vomiting is often observed in both the second and third degrees.

Children suffer more from burns than do adults, and women more severely than men. The temperature is not affected by burns of the first degree, but is a marked symptom in those of the second and third. At the time of the accident it may decline from 1 to 3 degrees below the normal—to 97° F. (36.1° C.) or even 95° F. (34.9° C.) and remain at that point until reaction begins, which is in about thirty-six or forty-eight hours, when it rises during the next twelve to eighteen hours to 104° F. (40° C.) or 106° F. (41.1° C.) or more, at which point it remains for a period of eight to ten days (possibly rising and lowering at irregular intervals), when granulations, now in fair formation, act as a retarding agent.

Vannini reported cases of six burns of varying degrees of severity, in all of

which glycosuria was present. The glycosuria was, as a rule, transitory, and was, in all probability, toxic in its origin, and connected with hyperglycemia. When sugar is present after burns, the diet of the patient should be modified.

COMPLICATIONS.—The after-effects of burns may be concentrated upon the viscera (neural, thoracic, and ventral cavities) or directly upon the part affected (cicatrices, contractions, and fractures of bone). Burns of the first degree remain uncomplicated, while those of the second and third present many variations. The meninges (arachnitis following burns of the head), as well as the brain proper, may become congested or even highly inflamed, the sufferer presenting all the symptoms of restlessness and delirium ending either in convulsions or coma. Tetanus is an early complication observed. Bronchitis and pneumonia often result either from inhalations or indirectly from surface burns. Congestion in the kidney has been noted, with resulting albuminuria or hemoglobinuria, while in many cases the urine becomes exceedingly scanty. Autopsies have shown rupture of the diaphragm and stomach, accompanied by contraction of the bladder. Amyloid degeneration in the viscera has been noted after prolonged suppuration. Inflammation of the gastrointestinal tract with the formation of an ulcer (usually one, but more rarely several) of the duodenum (at its pyloric end) frequently occurs. This ulceration may begin early (four or five days) or it may be delayed for weeks, although without the appearance of rectal hemorrhage or perforation, with consequent peritonitis, we have no means of determining its presence. At times this inflammation extends to the colon and causes diarrhea. Burns affecting either the chest or abdomen are the inducing cause, although severe burns at other points may produce them. Septicemia, pyemia, or erysipelas (the streptococci being found after death in the blood) may be the fatal ending.

The theories of the causes of death from burns may be divided into four classes: (1) death from shock or extreme pain; (2) embolism, thrombosis, and destruction of the blood-elements; (3) pyemic

infection through the burned surface; (4) poisons formed by the action of heat on the tissues, or autointoxication from deficient excretion by the skin. By experimenting upon dogs and rabbits it is personally claimed that the intoxication theory is the correct one.

The attempt of nature to restore a covering for these denuded tissues often results unwisely. Vicious scars, adhesions of contiguous parts (causing webbed fingers, the arm being attached to the side by granulations), and deformities may be encountered. Calcareous degeneration or even epithelioma may attack the scars. Pressure upon the terminals of the nerves may either cause neuralgia or spasm of the glottis, which may demand surgical interference for its removal. Finally, keloidal tumors may be observed as a consequence of vicious scarring. All of the scar may not be affected with keloid, as, for instance, one end may show the prolongations, while the other resembles ordinary cicatrices. The contractions of the skin after scarring may produce great deformity and the hand may be drawn backward upon the arm or talipes calcaneus may result or other disfigurements too numerous to mention may be shown. Exposure of joints has taken place by ankylosis. Bones have been fractured from loss of substance (cooking of the muscles).

DIAGNOSIS.—Ordinarily the recognition of burns is not a difficult task, although the differentiation of the varieties, especially of the second and third degrees, may demand careful examination. Burning flesh with destruction of its particles, exposure of the underlying tissues (muscles, bones, etc.), will be a train of symptoms not to be controverted. The difference between burns and scalds often may occasion difficulty, but the fact of the greater and deeper destruction of the former with the more superficial character of the latter will generally be sufficient. The loss of hair follows the former because of this deep destruction of the hair-follicle and papilla.

MEDICOLEGAL ASPECTS OF BURNS.—In cases where the persons have been alive when they were exposed to the fire, soot is found in the ramifica-

tions of the trachea and bronchi. If the red blood-corpuscles are found disintegrated and disfigured throughout, then this is a further sign of a person having been burnt while alive.

The presence of carbon monoxide in the blood is an almost positive proof that the person during life was not exposed to the influence of fire.

PROGNOSIS.—The termination of this class of injuries is often of serious import, especially when medicolegal questions arise. This should be determined by the several factors which arise in each case. Consideration must be given to individuality of the sufferer, both his age and constitutional acquirements; the extent of the burn, both as to surface and depth involved; the location of the injury, and the nature of the exciting medium. The effects upon strong, robust subjects are not so marked as upon those of weaker constitutions, and while the same degree or extent of burn will soon be recovered from by the former, the most dire results may follow in the latter persons. Thus it may be noticed that burns among machinists, glass-blowers, plumbers, and foundrymen will not be so serious as would the same degree or extent among clerks or those engaged in gentlemanly pursuits. Colored persons suffer less severely than do the white. Females, on account of more delicate system, are less able to resist shock than are the males. Middle life is not so severely affected as are children or aged people. Some persons may be able to resist the shock only to be carried off by the complications that arise.

Surface involvement seems to exert a greater depression or fatality than does depth of tissue. A burn, even of the first degree, which occupies an extended area and those of the second may terminate fatally if one-fourth or one-third of the superficial parts are involved; a fatal issue may also occur in burns occupying one-half of the body surface. A burn of the second degree which occupies only a limited extent of surface, but which destroys the epidermis entire, may end in recovery, while those of the third may, through their deep involvement, produce complications with which we are unable

to combat. Burns occupying the abdomen give the highest mortality, while those of the thorax are only second to a slightly minor extent; but those of the head, neck, and limbs prove fatal in many instances. Of twenty-six cases seen by Sajous after a boiler explosion on the Lake of Geneva, in 1892, twenty-two died within a few hours after the accident, although, with few exceptions, the scalds, though involving the greater part of the body, did not reach beyond the epidermic layer, excepting over the face and hands.

The length of time required for the partial or complete reparation of the surface may be an important question in medicolegal cases. This can only be governed by the type of injury, the length of contact of the exciting agent, the nature of the affected person, and the general aspects of the case in question.

TREATMENT.—**Constitutional.**—The constitutional treatment is to be directed toward the relief of pain, the restoration of the depressed vitality at the time of accident,—i.e., sustaining the system throughout the entire restorative process. Pain is best relieved by **opium**, or its alkaloid, **morphine** (preferably by hypodermic injection), because these agents have little, if any, depressing action upon the cardiac functions. The dose required will be much greater than ordinarily used, because of the sudden character and great amount of depression in these injuries.

Vitality must be restored as quickly as possible, and the use of **ammonia** (preferably **carbonate**), **strychnine**, and **caffeine** (because of their stimulating effect upon the cardiac muscle); **hot drinks**, such as milk and tea; **alcohol** in the form of whisky or brandy, and the **production** of local or generalized **sweating**. A most desirable plan of restoring heat is by using **hot-water bottles** placed at regular points so as to diffuse its effects. Other means, as, for instance, covering the body with a sheet and conveying heat through a pipe or by placing **heated bricks** beneath this covering. To keep the sufferer fairly comfortable during the local treatment stimulation must be kept up, care being taken not to produce overactivity and thus allow reaction to prove as deleterious as the effect of the burn.

The functions of the body must be regulated, the bowels being kept free or confined, according to the conditions present; the action of the kidneys should be watched. In some cases it may be wise to anesthetize the patient during the first few hours immediately following the burn, and especially during the first dressings of aggravated cases.

Local.—The local treatment is to be directed toward the limitation of the resulting inflammation, the prevention of septic infection, assisting the normal elimination of the eschar, the development of granulations, and limitation of the deformity.

In burns of the first degree little or no treatment may be demanded. In the more aggravated cases of this type the application of home measures, such as **sodium bicarbonate**, the **white of egg** and **sweet oil** (equal parts), **lead-water** and **laudanum**, and the various **hot or cold means** generally at the disposal of housewives.

Burns of the second and third degrees must be more strenuously treated. It is often a difficult problem to know which is the more soothing application to be advised and from which we may get the better result. In one case **hot applications**, in another **cold**; in some **wet**, and in others **dry** measures are to be given. The vesicles, if numerous, should be untouched; but if only a few, they are best evacuated.

Prof. S. D. Gross was wont, in many mild and severe cases, to use ordinary **white-lead paint**; this is a remarkably efficacious measure. Mere painting of the burn, as if it were an article of furniture, etc., causes immediate cessation of the pain.

The use of **carbolyzed petrolatum** (3 to 6 per cent.), watery solutions of **carbolic acid** (4 per cent.), **bismuth subnitrate** ($\frac{1}{2}$ to 1 dram—2 to 4 Gm.—to 1 ounce—30 Gm.—of ointment of **zinc oxide** or **petrolatum**), **boric acid** (either in watery saturated solutions or ointments of either **zinc oxide** or **petrolatum** in strengths varying from 6 to 25 per cent.), **sodium bicarbonate** in almost full strength (in ointment or watery solutions), and **starch** in varying proportions will usually be found very efficacious.

Turpentine, where granulations are sluggish, will give excellent results used either in full or diluted strength, giving care not to produce too much stimulation.

When there are large vesicles, these are opened on the second or third day. It is best to keep the turpentine off the healthy skin if possible to avoid local irritation.

Surgery of this day has placed many excellent antiseptics at our disposal, and there is no better application than **mercury bichloride** in the proportion of 1 to 1000 parts of water and kept in constant contact, the dressings being made without removing the former cloths.

Ichthyol in watery solutions (1 to 8, or stronger, or in glycerin, similar strength), or even in from 12 to 36 per cent. ointment with **zinc oxide** or **petrolatum** and the iodine derivatives, such as **iodol**, **aristol**, **europen** (given preferably in ointment 3 to 6 per cent. with **petrolatum** or lard) are reliable measures.

Thiol has been found useful for all degrees of burn; it allays pain very rapidly and arrests cutaneous hyperemia, in this manner tending to prevent ulceration and scarring.

Aristol is another valuable agent in burns of the second and third degrees, and has been found strikingly effective where other remedies have failed.

It may be used in the form of powder or mixed with oil or petrolatum. The application of **aristol** powder directly to the wound at the beginning hinders the dressing from soaking up the secretion; when the latter has diminished, however, **aristol** may be applied either alone or in a 10 per cent. ointment with olive oil, petrolatum, and lanolin.

Many authoritative surgeons have lauded **picric acid** used in saturated solutions with water (increasing the solubility by means of the addition of 1 ounce—30 c.c.—of **alcohol**, as the acid is soluble to the extent of only 2 drams—8 Gm.—to the quart—liter—of water). It is particularly useful for the relief of pain and it greatly assists the formation of granulations.

The combination of **picric** and **citric acids**, which Esbach devised for the detection of albumin, is more effective than the **picric acid** alone, in burns of the sec-

ond degree. **Esbach's** solution consists of 10 parts of picric acid, 20 of citric acid, and 1000 of water. The bullæ and vesicles should be opened with a clean blade and the fluid applied freely. Repeated application of **tincture of ferric chloride** is another useful form of treatment. **Calcined magnesia**, in a paste made with water, is serviceable in burns of the first and second degrees. **Iodoform**, as an analgesic and antiseptic, may be left *in situ* for some time. **Potassium nitrate** solution is useful, chiefly as refrigerant.

The **paraffin treatment** of severe burns constitutes a distinct advance over the procedures previously in general use. Besides forming a painless dressing, which is easy of application and removal, and does not favor infection, it results in more rapid healing, and leaves a smooth, soft, pliable scar, with little or no tendency to contracture and deformity. Either **ambrine** or one of the numerous substitutes for it may be used. The burn is first washed with **sterile water**, **saline solution**, or **boric acid solution**; it may be sprayed with a 3 to 5 per cent. solution of **dichloramine-T**, followed, if necessary, by **liquid petrolatum** to allay pain. It is then dried with sterile gauze or an electric dryer, and the paraffin preparation applied with a broad camel's hair brush or special spray apparatus. Shere recommends the following mixture:—

<i>White vaseline</i>	15 ounces.
<i>Liquid petrolatum</i>	2 ounces.
<i>Oil of eucalyptus</i>	1 ounce.
<i>Paraffin</i> (melt. pt. 42.7° C.) ..	16 ounces.
<i>White wax</i> ,	
<i>Pix burgundica</i> , of each	½ ounce.

For the first few days, 1 dram each of **thymol**, **iodide** and **menthol** are added to allay infection and pain; later, ½ to 1 per cent. of **scarlet red**, and when epithelialization is nearly complete, **bismuth subgalate**, 1 to 10. A thin layer of cotton is placed over the first layer of paraffin, a second paraffin coating applied, and the dressing completed with cotton and bandage. Redressing is done daily at first, later on alternate days.

The lethal tendency of burns is best met by removing the necrosed tissues and infusion of **saline solution**, repeated daily.

Granulations may often be assisted by powders of **acetanilide** in full strength, or with equal parts of **boric acid**, dusted over the area, or by means of **iodol**, **europphen** or **aristol** (3 to 12 per cent.) with powdered starch or in ointment. **Scarlet red** in 10 per cent. solution may also be used.

Limitation of deformity is often a serious problem though in some measure obviated by paraffin treatment. **Splints** may be utilized and they should be kept applied for some time after the parts have healed because of the inherent tendency to the contraction for long periods, even years, after an apparent cure. **Bandages** are to be kept continuously applied to prevent contiguous surfaces from becoming agglutinated. **Massage** must be advised at the very earliest moment so as to restore the pliability of the part and prevent ankylosis when a joint is involved. Even with all the measures that we can adopt the loss of skin-tissue may be so extensive that **skin-grafting** will be the only means with which we can hope to restore the integrity of the part. The relief of cicatrices or contractions, ankylosis, or pressure upon the nerve-filaments sometimes requires the most energetic surgical interference.

TREATMENT OF ELECTRICAL BURNS.—Elder advises that the part subjected to the burn be immersed and kept in a warm **carbolic-lotion bath**, 1 per cent., taking precautions against the possibility of the occurrence of secondary hemorrhage. If secondary hemorrhage occur, or when a definite line of demarcation has formed, the **necrosed tissue** must be removed. In many cases **amputation** is necessary, but the skin-flaps should not be closed, because large masses of muscle are sure to slough away subsequently. The wound should be allowed to granulate, and subsequently be **skin-grafted**. Immediately after the burn hypodermic injections of **morphine** ($\frac{1}{8}$ grain—0.01 Gm.) and **strychnine** ($\frac{1}{80}$ grain—0.002 Gm.) may be given alternately. To lessen the offensive odor the 1 per cent. carbolic lotion may be replaced by a bath of 1 in 10,000 **mercury bichloride**. In addition, **morphine**, **phenacetin**, **caffeine**, **chloral hydrate**, and **potassium bromide** may be administered together.

Immobilization of the part and **protection** with sterile gauze are necessary, and, if the burn is extensive, **skin-grafting**.

SCAR-TISSUE DEFORMITIES.

Scars, even when adherent to bones, painful thickenings following injuries or burns, or of the tendons, are favorably influenced by **X-rays**. Grace (Am. Jour. of Electr. and Radiol., Oct., 1919) uses a filter of 1 mm. of **aluminium** for the superficial cases and of 2 mm. for the deeper. The Palzsch method, a salve composed of **pepsin**, **hydrochloric acid**, and **phenic acid**, each 1 per cent., rubbed into the scar twice daily, is also effective according to Schuessler (Münch. med. Woch., lxxviii, 72, 1921). **Moist compresses** are applied at night.

C., W. and S.

SODIUM.—Sodium, or natrium, is a light, soft, ductile, malleable metal, of silver-white luster when freshly cut, and of dull-gray color when oxidized by air. Like potassium, it has a strong affinity for oxygen, and must be kept immersed in a liquid free from oxygen; such as benzene or naphtha. Thrown upon water, it burns with a bright yellow flame, uniting with the oxygen of some of the water and forming in the remainder a solution of sodium hydroxide. The pure metal is not used in medicine, but yields a larger number of official compounds than any other element.

Upon a therapeutic basis, the following classification of some of the sodium compounds may be made:—

Caustics: Soda, and soda with lime (unofficial).

Purgatives: Sodium phosphate, sodium sulphate, and potassium and sodium tartrate.

Systemic antacids: Sodium acetate, sodium bicarbonate, monohydrated sodium carbonate, sodium citrate, and potassium and sodium tartrate.

Diuretics: Sodium acetate, sodium benzoate, sodium bicarbonate, monohydrated sodium carbonate, sodium citrate, and potassium and sodium tartrate.

Febrifuges: Sodium acetate, sodium benzoate, sodium citrate, and sodium salicylate.

Antiseptics: Sodium benzoate, sodium borate, sodium chlorate, sodium hypochlorite, sodium phenolsulphonate, and sodium salicylate.

PREPARATIONS AND DOSES.

—The official preparations of sodium are:—

Sodii hydroxidum, U. S. P. (sodium hydroxide or hydrate; caustic soda), rapidly deliquescent, and acquiring a coating of sodium carbonate; soluble in 1 part of water and freely in alcohol.

Liquor sodii hydroxidi, U. S. P. (solution of sodium hydroxide), of about 5 per cent. strength. Dose, 10 to 30 minims (0.6 to 2 c.c.).

Liquor sodæ chlorinata, U. S. P. (solution of chlorinated soda; Labarraque's solution), an aqueous solution of several chlorine compounds of sodium, containing at least 2.4 per cent. by weight of available chlorine. Dose, 10 to 30 minims (0.6 to 2 c.c.).

Sodii acetas, U. S. P. (sodium acetate), soluble in 1 part of water and in 23 parts of alcohol. Dose, 10 to 30 grains (0.6 to 2 Gm.).

Sodii arsenas, U. S. P. (sodium arsenate). Dose, $\frac{1}{10}$ grain (0.006 Gm.). (See ARSENIC.)

Sodii arsenas exsiccatus, U. S. P. (dried sodium arsenate). Dose, $\frac{1}{20}$ grain (0.003 Gm.). (See ARSENIC.)

Liquor sodii arsenatis, U. S. P. (solution of sodium arsenate). Dose, 3 minims (0.2 c.c.). (See ARSENIC.)

Sodii benzoas, U. S. P. (sodium benzoate), soluble in 1.6 parts of water and in 43 parts of alcohol. Dose, 10 to 20 grains (0.6 to 1.3 Gm.). (See BENZOIC ACID.)

Sodii bicarbonas, U. S. P. (sodium bicarbonate, acid sodium carbonate, baking soda), soluble in 12 parts of

water, insoluble in alcohol; converted into sodium carbonate on boiling its solution. Dose, 10 to 60 grains (0.6 to 4 Gm.).

Sodium bicarbonate should only be given in small doses (12 to 15 grains—0.75 to 1 Gm.) several times daily. The acidity is thus diminished sufficiently to reduce the pain, yet an increased flow of acid is not stimulated. It has been proven that 15 to 45 grains (1 to 3 Gm.) given before, during, or after a test-meal will favor the passage of the food from the stomach into the intestines, while larger doses may cause a spasm. Even if the drug is given for a long time in the doses mentioned, cachexia will not set in. The fear that overloading of the blood with sodium may lead to increased production of hydrochloric acid is very remote. E. Binet (*Progrès méd.*, 3, 1911).

Trochisci sodii bicarbonatis, U. S. P. (troches or lozenges of sodium bicarbonate), each containing 3 grains (0.2 Gm.) of the bicarbonate and $\frac{1}{6}$ grain (0.01 Gm.) of nutmeg.

Mistura rhei composita, N. F. (mixture of rhubarb and soda). Dose, 2 fluidrams (8 c.c.). (See RHUBARB.)

Sodii bisulphis, U. S. P. VIII (sodium bisulphite; acid sodium sulphite; leucogen), unpleasant in taste, gradually oxidized to sulphate on exposure to air, soluble in 3.5 parts of water and in 70 parts of alcohol. Dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Sodii boras, U. S. P. (sodium borate; borax), soluble in 20.4 parts of cold water, in 0.5 part of boiling water, and in 1 part of glycerin, with which it reacts to form boroglyceride, with evolution of gas; insoluble in alcohol. Dose, $7\frac{1}{2}$ grains (0.5 Gm.). (See BORIC ACID.)

Sodii bromidum, U. S. P. (sodium bromide). Dose, 10 to 60 grains (0.6 to 4 Gm.). (See BROMINE.)

Sodii carbonas monohydratus, U. S. P. (monohydrated sodium carbonate), containing only one molecule of water of crystallization, and therefore nearly twice as strong as the ordinary sodium carbonate; soluble in 2.9 parts of water and in 8 parts of glycerin, insoluble in alcohol. Dose, 4 grains (0.25 Gm.).

Sodii cyanidum, U. S. P. (sodium cyanide), deliquescent and smelling of hydrocyanic acid; freely soluble.

Sodii glycerophosphas, U. S. P. (sodium glycerophosphate), saline in taste; freely soluble. Dose, 4 grains (0.25 Gm.).

Sodii chloridum, U. S. P. (sodium chloride; salt), at least 99 per cent. pure, soluble in 2.8 parts of water, almost insoluble in alcohol. Dose, as emetic, 4 drams (16 Gm.).

Sodii citras, U. S. P. (sodium citrate), with a cooling, saline taste; soluble in 1.1 parts of water, slightly soluble in alcohol. Dose, 10 to 60 grains (0.6 to 4 Gm.).

Sodii hypophosphis, U. S. P. (sodium hypophosphite), very deliquescent, soluble in 1 part of water and in 25 parts of alcohol. Dose, 5 to 30 grains (0.3 to 2 Gm.). (See PHOSPHORIC ACID.)

Syrupus hypophosphitum, U. S. P. (syrup of hypophosphites). Dose, 1 to 2 fluidrams (4 to 8 c.c.). (See PHOSPHORIC ACID.)

Sodii indigotindisulphonas, U. S. P. (indigo carmine), a blue powder or purple paste; sparingly soluble in water, yielding a dark blue solution.

Sodii iodidum, U. S. P. (sodium iodide). Dose, 5 to 60 (0.3 to 4 Gm.). (See IODINE.)

Sodii nitras, U. S. P. VIII (sodium nitrate; Chili saltpeter; cubic niter), with a cooling, saline, slightly bitter taste; soluble in 1.1 parts of water and

in about 100 parts of alcohol. Dose, 5 to 15 grains (0.3 to 1 Gm.).

Sodii nitris, U. S. P. (sodium nitrite). Dose, 1 grain (0.06 Gm.). (See NITRITES.)

Sodii phenolsulphonas, U. S. P. (sodium phenolsulphonate or sulphocarbolate), with a cooling, saline, bitter taste; soluble in 4.8 parts of water and in about 130 parts of alcohol. Dose, 4 grains (0.25 Gm.).

Sodii phosphas, U. S. P. (sodium phosphate; disodium hydrogen orthophosphate), efflorescent in the air; soluble in 5.5 parts of water, insoluble in alcohol; an aqueous solution, is slightly alkaline to litmus. Dose, 30 grains to 4 drams (2 to 15 Gm.). (See PHOSPHORIC ACID.)

Sodii phosphas effervescens, U. S. P. (effervescent sodium phosphate), containing 20 per cent. of exsiccated sodium phosphate, together with sodium bicarbonate, tartaric acid, and citric acid. Dose, 2 to 8 drams (8 to 30 Gm.). (See PHOSPHORIC ACID.)

Sodii phosphas exsiccatus, U. S. P. (dried sodium phosphate). Dose, 15 grains to 2 drams (1 to 8 Gm.). (See PHOSPHORIC ACID.)

Sodii perboras, U. S. P. (sodium perborate); gives off 9 per cent. of oxygen in warm or moist air; white crystalline granules or powder; soluble in water. Dose, grain (0.06 Gm.).

Liquor sodii phosphatis compositus, U. S. P. (compound solution of sodium phosphate), a 100 per cent. solution of sodium (citro) phosphate, containing also 4 per cent. of sodium nitrate. Dose, $\frac{1}{2}$ to 4 fluidrams (2 to 16 c.c.).

Sodii salicylas, U. S. P. (sodium salicylate). Dose, 15 grains. (See SALICYLIC ACID.)

Sodii sulphas, U. S. P. (sodium sulphate; glauber salt), rapidly efflores-

cent in the air; soluble in 2.8 parts of water and in glycerin, insoluble in alcohol. Dose, 1 to 8 drams (4 to 32 Gm.).

Sodii sulphis exsiccatus, U. S. P. (sodium sulphite), with saline, sulphurous taste; soluble in 2 parts of water, sparingly soluble in alcohol. Dose, 15 grains (1 Gm.).

Sodii thiosulphas, U. S. P. (sodium thiosulphate or hyposulphite), with a cooling, afterward bitter, taste; soluble in about 0.35 part of water, slightly soluble in oil of turpentine, insoluble in alcohol; the aqueous solution is rapidly decomposed by boiling. Dose, 5 to 20 grains (0.3 to 1.25 Gm.).

Potassii et sodii tartras, U. S. P. (Rochelle salt). Dose, 1 to 8 drams (4 to 30 Gm.). (See POTASSIUM.)

Among the sodium preparations recognized in the National Formulary are the following:—

Soda cum calce, N. F. (soda with lime; London paste), a paste consisting of sodium hydroxide and unslaked lime in equal parts, employed as escharotic.

Liquor antisepticus alkalinus, N. F. (alkaline antiseptic solution, containing, among other substances, sodium borate, sodium benzoate, and oil of gaultheria. (See SALICYLIC ACID.)

Liquor sodii arsenatis, Pearson, N.F. (Pearson's solution). (See ARSENIC.)

Liquor hypophosphitum, N. F. (solution of hypophosphites). Dose, 1 fluidram (4 c.c.). To replace the official syrup of hypophosphites when sugar is to be avoided.

Liquor hypophosphitum compositus, N. F. (compound solution of hypophosphites). Dose, 1 fluidram (4 c.c.).

Liquor sodii boratis compositus, N.F. (Dobell's solution), containing phenol, 0.3 per cent.; sodium borate and bi-

carbonate, of each, 1.5 per cent., and glycerin, 3.5 per cent., in sterile water.

Liquor sodii carbolatus, N. F. III (carbolated soda solution), consisting of phenol, 50 per cent. in water, together with sodium hydroxide, 3.5 per cent.

Liquor sodii citratis, N. F. (solution of sodium citrate; potio Riveri), made from citric acid, 2 per cent., and sodium bicarbonate, 2.5 per cent., in water. Dose, 2 fluidrams (8 c.c.).

Liquor sodii citrolicitratis efferves-cens, N. F. (tartro-citric lemonade). Dose, 12 fluidounces (360 c.c.).

Liquor sodii olcatis, N. F. III (solution of soap).

Elixir sodii bromidi, N. F. (elixir of sodium bromide). Dose, 2 fluidrams (8 c.c.), containing 20 grains (1.3 Gm.) of the bromide.

Elixir sodii hypophosphitis, N. F. (elixir of sodium hypophosphite). Dose, 1 fluidram (4 c.c.).

Elixir sodii salicylatis, N. F. (elixir of sodium salicylate). Dose, 1 fluidram (4 c.c.). (See SALICYLIC ACID.)

Syrupus bromidorum, N. F. (syrup of the bromides). Dose, 1 fluidram (4 c.c.).

Syrupus calcii et sodii hypophosphitum, N. F. (syrup of calcium and sodium hypophosphites). Dose, 1 fluidram (4 c.c.).

Syrupus sodii hypophosphitis, N. F. (syrup of sodium hypophosphite). Dose, 1 fluidram (4 c.c.).

Liquor sodæ et menthæ, N. F. (soda mint solution), consisting of aromatic spirit of ammonia, 1 part; sodium bicarbonate, 5 parts, in spearmint-water, enough to make 100 parts. Dose, 2 fluidrams (8 c.c.).

Syrupus hypophosphitum composi-tus, N. F. (compound syrup of hypophosphites), containing hypophosphites,

quinine, and strychnine. Dose, 2 fluidrams (8 c.c.).

Sodii borobenzoas, N. F. (sodium borobenzoate), a mixture of sodium borate, 3 parts, with sodium benzoate, 4 parts. Dose, 10 to 30 grains (0.6 to 2 Gm.).

Sal Carolinum factitium, N. F. (artificial Carlsbad salt), an amorphous powder consisting of sodium sulphate (dried), 18 parts; sodium bicarbonate, 36 parts; sodium chloride, 18 parts, and potassium sulphate, 28 parts. To be dissolved in 200 parts of water. Dose, 6 fluidounces (200 c. c.), representing an equal volume of Carlsbad water (Sprudel). If the crystalline preparation of the same nature be used, 1.75 parts of the salt are to be dissolved in 200 parts of water.

Sal Kissingense factitium, N. F. (artificial Kissingen salt), consisting of sodium chloride, 357 parts; sodium bicarbonate, 107 parts; magnesium sulphate (anhydrous), 12 parts, and potassium chloride, 17 parts. One and a half parts of the salt are to be dissolved in 200 parts of water. Dose, 6 fluidounces, representing an equal volume of Kissingen water (Rakoczy).

Sal Vichyanum factitium, N. F. (artificial Vichy salt), composed of sodium bicarbonate, 846 parts; sodium chloride, 77 parts, and magnesium sulphate (anhydrous) 80 parts, and potassium carbonate, 38 parts. To be dissolved in 200 parts of water. Dose, 6 fluidounces (200 c.c.), representing an equal volume of Vichy water (Grande Grille spring).

Pulvis salis Carolini factitii efferves-cens, N. F. (effervescent artificial Carlsbad salt). Dose, 90 grains (6 Gm.) in 6 ounces (200 c.c.) of water.

Pulvis salis Kissingensis factitii ef-fervescens, N. F. (effervescent artifi-

cial Kissingen salt). Dose, 80 grains (5.5 Gm.) in 6 fluidounces (200 c.c.) of water.

Pulvis salis Vichyani factitii effervescens, N. F. (effervescent artificial Vichy salt). Dose, 57 grains (3.75 Gm.) in 6 fluidounces (200 c.c.) of water.

Pulvis salis Vichyani factitii effervescens cum lithio, N. F. (effervescent artificial Vichy salt with lithium). Dose, 90 grains (6 Gm.), representing 14 grains (1 Gm.) of artificial Vichy salt and 5 grains (0.3 Gm.) of lithium citrate.

PHYSIOLOGICAL ACTION.—

Sodium as an element or ion exerts in moderate amounts, different from potassium, little or no effect upon the tissues of higher animals. That the sodium ion may exert a deleterious action on some animal cells is shown, however, by the observation that some ova and fish ordinarily inhabiting sea-water survive longer when placed in distilled water than when placed in a solution of sodium chloride isotonic with sea-water. More concentrated solutions of sodium chloride, in addition to a possible ionic poisonous effect of the kind just described produce the effects characteristic of "salt action" in general, viz., withdrawal of water from cells, with corresponding shrinkage of the latter and, where the occasion presents, effects due to irritation, such as vomiting in the case of the stomach.

According to the experiments of Münch, exhibition for a few days of large quantities of sodium chloride in man causes at first a slight decrease in excretion (especially renal), with a corresponding gain of body weight; after a time, however, the excretions increase and the weight decreases.

Small amounts of salt have been found at times to lessen the acidity of the gastric juice, but the greater palatability of food seasoned with salt may counteract this by augmenting the reflex gastric secretion. The salivary flow is increased by salt, partly through reflex action and partly because some of it is excreted by the salivary glands.

Absorption of ingested hypotonic solutions of salt takes place chiefly from the intestine, and results in a diluted condition of the blood—hydemia—which induces diuresis. The flow of urine is increased more by direct saline infusion into the blood than by saline solution (or water) absorbed from the stomach and bowel. Hypertonic salt solution injected into the blood causes marked diuresis through absorption of water from the body tissues, but hypertonic salt solution ingested causes little or no diuresis, as the salt is only slowly absorbed from it, and though tending, for a time, to increase the total bulk of the blood, does not render it hydremic.

Sodium hydroxide (caustic soda), like potassium hydroxide and calcium oxide, is a strong caustic, destroying tissue by abstraction of water, dissolution of albumin, and saponification of fats. Similar effects are produced by liquor sodii hydroxidi and by soda cum calce (N. F.).

Sodium hypochlorite, official in the liquor sodæ chlorinatæ or Labarraque's solution, gives off chlorine and possesses the antiseptic, deodorant, and bleaching properties of the latter. It is decidedly irritating to the tissues, but this property may be reduced, seemingly without loss of antiseptic power, by the addition of sufficient boric acid to neutralize the free alkali in the preparation.

Sodium acetate, like other salts of alkalies with the vegetable acids, is rapidly absorbed and oxidized in the system to form sodium carbonate, which increases the alkalinity of the blood and urine, and causes diuresis. Over direct ingestion of alkaline carbonates or bicarbonates, sodium acetate and similar salts have the advantage of not neutralizing the gastric juice.

Sodium bicarbonate, applied in solution to mucous membranes, exerts a soothing effect, and tends to dissolve thick mucus. It is mildly alkaline, but the alkalinity of its solutions increases on standing, because of the loss of carbon dioxide. Applied in dilute solution to isolated contractile organs, including vessel-walls and ciliated epithelium, it causes for a time, like other dilute alkalies, increased activity and tonicity, and in certain protozoa an increased resistance to asphyxia from oxygen exclusion; later, the augmented activity is replaced by depression.

Experiments in dogs have shown that the alkaline carbonates, administered internally, do not influence the rate of gastric secretion. They tend, however, to increase gastric motility by virtue of the carbon dioxide liberated through reaction with the hydrochloric acid of the gastric juice, and may also in themselves, by inducing slight local irritation, exert a mild carminative effect, relieving gaseous distention and the consequent pain. Five grains (0.3 Gm.) of sodium bicarbonate, if completely utilized in the destruction of the gastric acid, are capable of neutralizing about $1\frac{1}{2}$ ounces of gastric juice of 0.3 per cent. strength. Where the stomach contains no acid, as in the resting period between the digestion of successive meals, sodium bicarbonate simply dissolves the

gastric mucus and is absorbed unchanged. Neutralization of the gastric acid has been held to reduce pancreatic secretion, the normal stimulus to the pancreas resulting from the entrance of acid into the duodenum having been partly or completely removed. In gastric hyperacidity, however, it may, nevertheless, be beneficial by allaying excessive irritation by the gastric acid in the duodenum, thereby relieving catarrh of the latter. Stadelmann and others have shown that alkalies exert no direct influence on the secretion or reaction of the bile, in spite of former views to the contrary. According to some, sodium bicarbonate exerts a mild laxative effect. Once absorbed into the blood, sodium bicarbonate increases the alkalinity of the latter, though its rapid excretion renders it difficult to obtain a lasting result in this respect. The acidity of the urine is reduced and its total output increased; where enough has been given to render the urine alkaline, sodium bicarbonate may be found in it unchanged.

Sodium bicarbonate always stimulates the gastric secretions. In hyperchlorhydria it should be given in large doses some time after meals, so that the food can leave the stomach before the excessive acidity of the chyme has been restored. The drug has a remarkable soothing action on the tardy pain of digestion, even in secretory insufficiency. In hypochlorhydria the best results are obtained with an interval of two hours before the meal for a dose of 0.5 Gm. (7.5 grains); three hours for twice this dose, and four hours for a dose of 5 Gm. (75 grains). Very small doses can be given even with the meals. The drug renders the stomach content alkaline, and under the stimulation of this the secretions gradually pour out to neutralize the alkalinity, and normal acidity is thus

in time regained or even surpassed. Linossier (Bull. de l'Acad. de Méd., Apr. 14, 1908).

Sodium carbonate, official as the monohydrated salt, is more strongly alkaline than the bicarbonate, though far less corrosive than sodium hydroxide, and causing manifest injury to the skin only after very protracted contact. The effects of ingested sodium carbonate are the same as those of the bicarbonate, though the salt is more irritating than the bicarbonate. Investigations have shown that alkalis exert little or no effect on the total output of nitrogenous wastes, though the ammonia of the urine is often diminished and the urea correspondingly augmented, especially in individuals with an excess of acid in the tissues, the alkalis neutralizing acid which would otherwise excite the production of ammonia in the system. No definite change in uric acid metabolism from alkaline medication has been detected. Rabbits treated with alkalis exhibit greater resisting power to anthrax infection than controls. The reaction of the urine is strongly affected by sodium carbonate, $2\frac{1}{2}$ to 4 drams (10 to 15 Gm.) of the salt in twenty-four hours being nearly always sufficient to produce and maintain an alkaline condition; an alkaline reaction lasting two or three hours may often be brought about by a single dose of 30 to 45 grains (2 to 3 Gm.) (Cushny).

Sodium chlorate possesses the same therapeutic and toxic properties as potassium chlorate. (See POTASSIUM.)

Sodium citrate, like potassium citrate and sodium acetate, is absorbed from the intestine, probably after partial decomposition by hydrochloric acid in the stomach, and is then quickly and completely oxidized in the system to form

sodium carbonate. Sodium citrate being less readily absorbed than the acetate, a cathartic effect is more likely to result, provided a fairly large amount, such as 30 grains (2 Gm.), is given. A portion of the drug is, however, absorbed and exerts alkalinizing and diuretic effects. Citrates prevent or delay the coagulation of blood and the clotting of milk by rennin, owing to their affinity for calcium. Introduction of the citrate into the system apparently does not, however, produce such an effect on the circulating blood, doubtless because it is promptly changed to the carbonate.

Sodium nitrate exerts chiefly a diuretic effect, though it is considered somewhat inferior to potassium nitrate in this connection. The diuresis is generally ascribed to the salt-action of the drug exerted in the blood-stream, but the possibility of a direct excitant effect on the kidney is also recognized. Moderate amounts of the nitrates, when ingested, fail to appear in the urine as such, apparently being broken down in the system, probably in part to nitrites and ammonia. The specific action of the nitrate ion is to cause irritation of any mucous surface with which it comes in contact. The nitrates should always be given well diluted, and administered only with caution in the presence of gastrointestinal irritation, as they produce such irritation themselves when given in large amounts.

Sodium phenolsulphonate (sulphocarbolate) is absorbed and excreted unchanged. It has antiseptic properties, is less toxic than phenol, and has been used internally to check gastric fermentation.

Sodium sulphate (Glauber's salt) is only with difficulty absorbed from the intestinal tract, and exerts a purgative

action by increasing the fluid content of the bowel. If administered in a relatively small amount of water, it draws more water from the surrounding tissues by salt action as it passes down; if given, on the other hand, in a large amount of water, it merely keeps this water from being absorbed, thus again producing an abnormal fluidity of the intestinal contents. The small proportion of the salt which is absorbed into the blood—this proportion varying inversely with the amount of the drug given, the larger amounts producing more rapid evacuation—causes a hydremia and consequent diuresis, which occurs later than with sodium chloride, owing to the slower absorption of the sulphate. The more marked the purgative effect, the less pronounced the diuretic. Recent investigations have not substantiated the view that sodium sulphate and other saline cathartics increase the secretion of bile.

Notwithstanding its harsh, unpleasant taste, sodium sulphate is relatively non-toxic to tissues in general, and may be administered in large amounts without inconveniences other than those of salt action.

Sodium sulphite and *sodium bisulphite* act as deoxidizers, absorbing oxygen from organic matter to become transformed into sulphates. Practically all of each of these salts that is absorbed is oxidized in this way. Given internally in not too large amounts the sulphites thus act as non-toxic, though rather irritating, antiseptics. Rapid absorption of large quantities, however, brings about the true sulphite action, which consists of depression of the medullary centers and circulatory musculature, with death from asphyxia as a possible termination.

Sodium thiosulphate (hyposulphite) acts like the preceding salts, but is oxidized in the system with greater difficulty, a considerable proportion passing out unchanged in the urine. It is credited with much value as a deodorant.

POISONING BY SODIUM AND ITS SALTS.—The sodium salts, as a whole, are less poisonous than those of potassium, as they lack the direct toxic action of potassium on the heart. Sodium salts given in two or three times the quantity which would prove fatal in the case of potassium salts, produce no effect on the system except a passing weakness. Sodium hydroxide, however, is a powerful corrosive, and leads to serious results when ingested by mistake, or—uncommonly—for the purpose of suicide.

SODIUM HYDROXIDE.—Strong solutions of caustic soda, placed in contact with the tissues, tend to penetrate deeply by dissolving proteins, and produce marked destruction of tissue. The semitransparent crust at first formed usually drops off after some days, an ulcer remaining which is slow to heal.

Taken internally, concentrated solutions of sodium hydrate produce marked corrosion of the mouth, extending down to the throat, esophagus, and stomach. In the latter, perforation resulting in peritonitis may occur; or, death may take place from the widespread destruction of tissue, or, later, from gradual starvation due to cicatricial obstruction in the alimentary passages.

Treatment of Poisoning by Sodium Hydroxide.—This comprises the administration of dilute acids, preferably of the vegetable group, such as

acetic, citric, or tartaric acid, which are often available in the form of **vinegar, or lemon-juice**. Passage of a stomach-tube is dangerous, as it might penetrate the corroded gastric wall.

Olive oil, lard, white of egg, or milk, should be given as demulcents. **Morphine** may be given to alleviate the pain. Stimulants may be required to combat collapse; **external heat** should also be applied under these circumstances. Later, the passage of **bougies or surgical procedures** to overcome stenosis may be necessary.

SODIUM BICARBONATE AND CARBONATE.—Sodium bicarbonate is free of caustic action, but the carbonate may corrode tissues when applied for some time in concentrated solution. Giving large amounts of the alkaline carbonates and bicarbonates to animals has been observed to induce a chronic gastroenteric inflammation, which may prove fatal.

Sodium bicarbonate in large doses, such as 300 grains (20 Gm.) or more daily, may cause an increase in body weight, due to retention of chlorides with resultant water retention, which may go on to the appearance of edema. This condition is most likely to appear during the administration of the bicarbonate to cachectic diabetics with acidosis, but it can be produced in an experimental way in normal individuals. L. A. Levison (Jour. Amer. Med. Assoc., Jan. 23, 1915).

SODIUM CHLORIDE.—Serious symptoms and frequently death have resulted from the introduction of a large quantity of sodium chloride into the system. Such poisoning occurs oftenest from the inadvertent use of a strong salt solution instead of normal saline solution for proctoclysis or

intravenous infusion, but is reported also to be a common method of suicide in one of the provinces of China, a pint or more of saturated salt solution being ingested for this purpose. Combs reported a fatal case, with crenation of the erythrocytes in fresh blood, in a woman who received about 4 ounces (120 Gm.) of salt in a strong solution by hypodermoclysis.

The symptoms of sodium chloride poisoning consist of nausea, vomiting, diarrhea, fever up to 104° F. (40° C.), delirium or coma, and fatal collapse. In cases with diminished renal permeability and salt retention, as in nephritis or eclampsia, even normal saline solution may increase edema and induce edema of the lungs, or the vomiting of fluid rich in chlorides (Bastedo). Marked edema of the legs from prolonged use of large amounts of salt with the meals has also been reported.

Case of a healthy boy of 5 years who received an injection of strong brine as a domestic remedy for worms. The mother made the mistake of putting a pound instead of a tablespoonful of salt in a quart of water. In five or ten minutes the child was taken with pain in the head, intense thirst, and vomiting, soon followed by severe purging. In thirty minutes he had become unconscious, and one convulsion followed another until death occurred five hours after the injection. O. H. Campbell (Jour. Amer. Med. Assoc., Oct. 5, 1912).

SODIUM NITRATE.—The nitrates, in excessive amount, especially if taken in concentrated form, cause gastric pain, nausea, vomiting, and sometimes diarrhea. Blood may be eliminated with the vomitus and stools. Either diuresis or oliguria may be noted. Further symptoms

are motor weakness, mental dullness, collapse, and coma, terminating in death. Dilute nitrate solutions may be taken in large amount without trouble, but the more concentrated ones induce the symptoms referred to.

SODIUM SULPHATE.—Large amounts of a strong solution of this salt cause repeated alvine discharges, which finally consist chiefly of mucous fluid stained with bile. Serious poisoning with it is rare.

SODIUM SULPHITE AND THIOSULPHATE.—Although large amounts of the sulphites have been taken by man without the production of poisoning, symptoms or irritation of the alimentary tract have been noted after even small doses. Some of the irritation of the stomach is ascribed to the liberation of sulphurous acid by the hydrochloric acid of the gastric juice.

THERAPEUTICS. — **Gastrointestinal Disorders.**—The alkaline salts of sodium, especially the bicarbonate, are used extensively in disorders of the alimentary canal. Given in the digestive period, the bicarbonate diminishes the secretion of gastric juice, neutralizes some of the hydrochloric acid, and acts as a carminative by setting free carbon dioxide. Where organic acids are present, it may likewise neutralize them, and by doing so lead to the opening of a pylorus previously in spasm.

In continuous **gastric hyperacidity** and in cases with **gastric fermentation** and resulting "sick headache," preparation of the stomach for a meal may be effected by giving a dose of sodium bicarbonate an hour before it. In the fermentation cases combination of calomel with it may be advantageous. For **hyperchlorhydria**

manifesting itself after meals, the drug is also very effective, and is beneficial, especially when taken one to two hours after the repast. A combination of sodium carbonate and magnesium oxide may be even more grateful, the latter compound exerting, in addition, a local sedative effect. Where, however, stimulation of evacuation is particularly desired, an effervescent mixture of sodium bicarbonate, 30 grains (2 Gm.), with tartaric acid, 10 grains (0.6 Gm.)—dissolved separately in half a glassful of water, then mixed—is of value. Such a mixture may also prove useful in the **vomiting attending acute inflammatory diseases** and the **exanthemata**.

The early morning acidity of hyperacid cases may be prevented by the exhibition of a dose of sodium bicarbonate the night before. Mucus may be removed from the stomach, preparatory to breakfast, by a dose taken on arising. In **alcoholic gastritis** lavage with a dilute sodium bicarbonate solution is useful for the same purpose.

In **gastric hyperacidity** alkalies have two indications. They may be employed in the late pain of hyperacidity, but the tendency of the patient toward abuse of the drug must not be forgotten, for excessive use may cause gastritis. The author prefers bismuth subnitrate in large doses to the alkalies. The alkalies may also be employed to hasten the digestive process; here the so-called Vichy cure may likewise prove beneficial. The use of artificial Carlsbad salt seems, however, of greater value, the results being more lasting. Hayem (*Tribune méd.*, xli, 281, 1908).

The prolonged suppression of salt in the diet reduces pain and vomiting in conditions of hyperacidity, while

in other conditions in which the HCl is deficient the use of salt increases it and aids digestion greatly. The author's experiments on a healthy man, following out L. Meunier's technique, showed that with certain foods, as meat, the digestion was the same with or without salt, but with other foods, such as milk, eggs, and carbohydrate foodstuffs, the digestion was delayed from ten to twenty minutes when no salt was given with them. Thus, in certain subjects and with certain foodstuffs, the addition of sodium chloride to the diet favors the gastric secretion. A. Martinet (Presse méd., Apr. 1, 1908).

In children, where an antacid is required and constipation is present, sodium bicarbonate is preferable to lime-water.

In **yeasty vomiting**, especially when *sarcinae* are present, sodium sulphite is often of value in doses of from 5 to 20 grains (0.3 to 1.3 Gm.). The vomiting due to acid fermentation of starches and sugars may be relieved by the same salt in doses of from 20 to 60 grains (1.3 to 4 Gm.), or by sulphurous acid, in doses of from 5 to 60 minims (0.3 to 3.6 c.c.), well diluted).

In cases with **dyspeptic pains associated with motor insufficiency**, E. Binet recommends the use of two of the following powders at intervals, respectively, of one hour and half an hour before meals, and, if necessary, at the same intervals after meals:—

R. Sodii bicarbonatis. gr. xij (0.75 Gm.).
Magnesiæ oxidi ponderosi gr. iv (0.25 Gm.).
Pulveris belladonnæ foliorum gr. ½ (0.01 Gm.).
 Pone in chartulam no. j.

Where there is **pylorospasm due to hypersecretion**, a powder should be taken one hour after the meal and re-

peated at one and one-half-hour intervals until the next meal.

In **duodenal ulcer** sodium bicarbonate may give relief when the "hunger pain" appears.

In **catarrhal jaundice**, sodium bicarbonate, combined with rhubarb, has been considered especially useful. The official mixture of rhubarb and soda may be given.

In **chronic hepatic affections** good results have at times followed the use of the solution of chlorinated soda, in doses of from ½ to 2 drams (2 to 8 Gm.), diluted in from 4 to 8 ounces (120 to 240 c.c.) of water.

In **constipation** sodium sulphate is not as often employed as some other drugs in human beings, though largely used in veterinary practice, as it is one of the most irritant of the saline purges, producing large, watery stools with considerable griping. The purgative dose is from ¼ to 1 ounce (7½ to 30 Gm.). It should be used with some caution if any intestinal inflammation be present. It is one of the constituents of Carlsbad, Hunyadi, and similar waters. According to Maberly, it frequently acts as an intestinal antiseptic in small doses.

Sodium sulphate is an intestinal antiseptic. After observation of its action in **dysentery** and **infantile diarrhea**, the writer relies almost entirely on it in all septic bowel complaints. To obtain the antiseptic action one must avoid doses having an aperient action. The dose should begin with about 6 grains (0.4 Gm.) for a baby under 6 months of age, increasing up to 1 dram (4 Gm.) for adults, given every six hours in one of the flavored waters, such as fenel. Children over 6 months old seldom exhibit any aperient effects from doses of 14 to 20 grains (0.9 to 1.3 Gm.). The writer also uses the drug in **typhoid fever**; the stools,

from being loose and fetid, become more normal in appearance and odor, and the temperature runs a lower course. Maberly (*Lancet*, Nov. 10, 1906).

For diuretic purposes, 4 Gm. (1 dram) of sodium sulphate may be dissolved in 1 or 1½ liters (quarts) of water, to be divided into three doses, one in the early morning, on a fasting stomach; one in the forenoon, and one in the afternoon; the water must be sipped slowly. For a light, non-irritating purgative effect, 5 Gm. (1¼ drams) of the salt may be dissolved in ½ or ¾ liter (quart) of water, to be divided in two doses, one in the early morning and one an hour before the noon meal; it should be taken warm. For an energetic purgative action, 25 to 60 Gm. (6 to 15 drams) of sodium sulphate are to be dissolved in 200 c.c. (6 ounces) of water, sweetened if desired, or flavored with lemon, peppermint, or anise-seed, according to taste, to be taken at one dose. Alfred Martinet (*Presse méd.*, Aug. 23, 1911).

Physiological salt solution passes through the gastrointestinal tract without irritating it or interfering with osmotic conditions. There is nothing which passes along so rapidly. The writer has patients drink 2 glassfuls of a 0.9 per cent. solution of sodium chloride twenty minutes before breakfast. After nine or twelve minutes defecation followed. The stomach expels the solution promptly, and reflexly sets up peristalsis throughout the intestinal tract. The larger the amount ingested the more rapid the passage. Most mineral waters are hypertonic and are absorbed in the duodenum unless large quantities are taken. After drinking the salt solution on an empty stomach in the morning the writer has the patient follow it with a cup of coffee or other appetizing drink. In atony of the stomach, the rapid expulsion of the physiological salt solution makes it a valuable regulator of the bowels. Best (*Med. Klinik*, July 27, 1913).

The use of sodium citrate has been strongly recommended in the treatment of **digestive disorders**, especially in **children**, as well as in **acidosis** and in **pneumonia**. According to Lacheny, 15 grains (1 Gm.) of the salt allay **dyspeptic pain in the stomach** and 23 grains (1.5 Gm.) promptly arrest most attacks of **vomiting**.

The chief uses of sodium citrate in **infant feeding** are as follows: (1) for weaning the healthy infant; (2) for increasing the amount of milk taken in the twenty-four hours; (3) for correcting milk dyspepsia, and (4) for the avoidance of scurvy. It is not antibacterial. A good proportion is 1 grain (0.065 Gm.) of sodium citrate to the ounce (30 c.c.) of milk. Poynton (*Brit. Med. Jour.*, Oct. 21, 1905).

Good results obtained from the use of sodium citrate added to milk in **infant feeding** when gastric disorders, especially **vomiting**, exist. When sodium citrate is added to milk the coagulum is less solid and lighter. This is due to the fact that in the presence of sodium citrate the calcium salts, especially the chloride, which augment coagulation, are precipitated. It is usual to administer 1 to 2 Gm. (15 to 30 grains) a day to infants. Vomiting due to hypalimentation may derive as much benefit from its use as that due to superalimentation. The drug is superior to bicarbonate of sodium in digestive disturbances in adults, and does not cause a secondary secretion of acid in the stomach. Variot (*Tribune méd.*, Oct., 1910).

Sodium citrate facilitates the digestion of milk when a milk diet is being given, preventing the formation of large, compact clots where the fluid is drunk too quickly or in excessive amounts at one time. Many cases of **infantile dyspepsia** yield when a tablespoonful of a 10-grain (0.65 Gm.) to the ounce (30 c.c.) solution of sodium citrate is added

to each 4-ounce (120 c.c.) bottle of milk.

Sodium citrate also acts as an alkali, is soothing in **pyrosis**, diminishes **gaseous fermentation**, and even obviates the **regurgitation of food**.

Even in small doses, it is a good laxative. In **constipation in dyspeptics** it lessens autointoxication and obviates mechanical disturbances. In **constipation associated with hepatic congestion**, Huchard frequently advised its employment, along with sodium sulphate and bicarbonate:—

℞ *Sodii citratis*,
Sodii bicarbonatis,
Sodii sulphatis... āā 3v (40 Gm.).

M. Sig.: One teaspoonful every morning in a hot infusion.

Plicque (Bull. méd., May 31, 1913).

In certain conditions of **malnutrition**, **marasmus**, and **chronic indigestion in infants and children**, Le Boutillier and others have recommended subcutaneous injections of a *dilute sea-water solution*.

In applying the sea-water treatment in infants, the writer followed the Robert-Simon method, diluting 83 parts of sea-water with 190 parts of pure spring-water, filtering through a germ-proof Berkefeld filter, and putting it up in sterile bottles. The usual injection sites were just below the angle of the scapula or in the gluteal regions, the former being preferable. The amount injected varied from 10 to 60 c.c. (2½ drams to 2 ounces), the usual dose being 15 to 30 c.c. (½ to 1 ounce), according to age and urgency, and from three times a week to every day for a short time. Sometimes five or six injections improved the condition so much that the patient was discharged. In other cases the treatment had to be kept up for several months. There is improvement in the amount of food taken within the first two or three weeks; this is noticeable in older children suffering from malnutrition or chronic indigestion. In infants,

distressing colic was invariably relieved within the first two weeks. The skin, often harsh, dry, and scaly, cleared up entirely, whether in infants or in older children. The patients who were losing weight or stationary, as a rule, gained after the first few treatments, sometimes as much as an ounce a day. The sleep of many patients was markedly improved. The treatment is a useful adjunct of other methods in the **malnutrition of tuberculous disease** or that following any of the **infectious diseases**. T. LeBoutillier (Jour. Amer. Med. Assoc., Jan. 1, 1910).

In the **cyclic vomiting of children**, rectal or oral administration of a 2 per cent. solution of sodium bicarbonate is an essential measure where acidosis exists, in conjunction with the administration of dextrose, sedation of the vomiting reflex by means of drugs, and exhibition of fluids in copious amounts.

In **cancer of the stomach** the use of sodium chlorate has, in some cases, been followed by good results. The initial dose recommended by Brissaud is 2 drams (8 Gm.) daily, in divided doses; this is gradually increased until 4 drams (16 Gm.) are taken. If albuminuria be present or develop, the drug is contraindicated.

In **mercurial stomatitis**, **aphthæ**, **mucous patches**, and **ulcers of the tonsils**, sodium sulphite in 1 to 8 solution may be applied with a cotton pledget, or in the form of spray.

Calomenopoulo has emphasized the utility of sodium chlorate in **mercurial stomatitis**. He also noticed that sodium chlorate in large doses reduced intolerance to potassium iodide where this drug was being taken in full doses for syphilis.

Seatworms (*Oxyuris vermicularis*) may be dislodged from the rectum by

injection of a solution of the chloride, and, with them, the intense itching. The injections should be given every morning, then every two to four evenings, with the buttocks elevated or in the Knee-chest posture until all evidence of the worms has disappeared.

In **dysentery** the use of sodium nitrate in dram (4 Gm.) doses, freely diluted, every three hours, has been recommended.

Cutaneous Disorders.—In acute **eczema**, when there is much serous discharge, the following application is efficient: Sodium carbonate, $\frac{1}{2}$ dram (2 Gm.); water, 1 pint (500 c.c.). The solution may be made stronger in old cases where the skin is much thickened. When the weeping has ceased and mere desquamation remains, the alkali ceases to be of use.

The **pruritus of eczema**, **lichen**, **urticaria**, **dermatitis**, **burns**, and **frost-bite** may be relieved by applications of the following: Sodium bicarbonate, 3 drams (12 Gm.); glycerin and distilled extract of witchhazel, of each, 3 ounces (90 c.c.). The itching of urticaria and lichen will often yield to a 1:100 solution of sodium carbonate, applied with a sponge or mop.

Poison-ivy eruption and other forms of **pruritus** may be similarly soothed by sodium hyposulphite in solution (1 to 16), a solution of the bicarbonate, or by the solution of chlorinated soda, diluted 1 to 32.

In **parasitic skin diseases**, especially those due to the trichophyton fungus, as **pityriasis versicolor**, the hyposulphite (1 to 8) in solution or ointment is valuable. Startin has recommended the following: Sodium

hyposulphite, 3 ounces (90 Gm.); dilute sulphurous acid, $\frac{1}{2}$ ounce (15 c.c.); water, enough to make 1 pint (500 c.c.). In **tinea versicolor** and **pruritus vulvæ** Fox found the following useful: Sodium hyposulphite, 4 drams (16 Gm.); glycerin, 2 drams (8 Gm.); water, enough to make 6 ounces (180 c.c.).

In **scabies** also the hyposulphite has been used successfully. After the morning bath apply the hyposulphite in solution (1 to 1) to the affected part and allow it to dry on the skin. At night bathe with the following lotion, which may be diluted if found too strong: Dilute hydrochloric acid, 4 ounces (120 c.c.); distilled water, 6 ounces (180 c.c.) (Ohmann-Dumesnil).

For the **removal of freckles**, **sunburn**, and **tan** the following lotion may be used: Sodium chloride, 2 drams (8 Gm.); potassium carbonate, 3 drams (12 Gm.); rose-water, 8 ounces (240 c.c.); orange-flower-water, 2 ounces (60 c.c.). The inflammation of sunburn may be subdued by applications of sodium bicarbonate in solution.

In **hyperidrosis of the feet** and **axillæ** a solution of the carbonate freely applied locally will remove the fetor and diminish the secretion of sweat.

In **burns** and **scalds** sodium bicarbonate in powder or in solution relieves the pain and soreness very promptly. It may also be applied with advantage to insect bites.

The carbonate is used externally when it is desirable to soften or remove scaly or scabby accumulations upon the skin, as in certain forms of **eczema**, **plica polonica**, etc.

In **tuberculous ulcers** and in **psoria-**

sis, good results have at times been secured with hypodermic injections of *diluted sea-water*, as originally suggested by Robert-Simon and Quinton.

Genitourinary Disorders.—Irritation of the urinary passages due to an excess of acid may be allayed by sodium bicarbonate in doses of 10 to 20 grains (0.6 to 1.3 Gm.), given in a glass of water, every four hours.

In **cystitis** a 1 per cent. solution of the bicarbonate may be used to wash out the bladder when an acid condition of that viscus exists.

Some relief is afforded in **gonorrhea** by injections of a 1 per cent. solution of the bicarbonate.

In **malarial hematuria** sodium hyposulphite is given with advantage in doses of from 10 to 30 grains (0.6 to 2.0 Gm.), every four hours. Its mode of action is unknown.

Fischer's solution, containing 10 Gm. (150 grains) of sodium carbonate (crystallized) and 14 Gm. (210 grains) of sodium chloride to the liter (quart) of water, has been used intravenously in amounts up to 2 liters (quarts) for the relief of **anuria in scarlet fever, eclampsia, Asiatic cholera**, etc. In less urgent cases of impaired renal function, including cases of **chronic nephritis**, the sodium bicarbonate may be increased to 15 to 30 Gm. (225 to 450 grains) in the liter, and the solution given per rectum by the drop method.

Sodium chloride having long been known as a powerful diuretic, the writer used it as a last resort in advanced **nephritis**, and obtained striking benefit after a prolonged period on a salt-free diet. When no benefit follows the salt-free diet, a single large amount of sodium chloride, 1 to 3 days during the week, may induce

marked diuresis and considerable clinical improvement. Polag (*Schweizer. med. Woch.*, i, 29, 1920).

Laryngologic and Respiratory Disorders.—In **asthma** the use of potassium nitrate in 3- or 4-grain (0.2 or 0.26 Gm.) doses has been highly commended. The drug is probably, in part, changed to a nitrite in the system, and acts as such.

In **pulmonary hemorrhage** the administration of dry salt is a popular remedy.

Use of salt by the mouth or in infusion recommended to control hemorrhage. Salt enhances the coagulating power of the blood in the living subject, though not in the test-tube. This may be due to the mobilization of thrombokinase stored up in the tissues. In 29 cases of hemoptysis the writer obtained excellent results by giving 75 grains (5 Gm.) of **sodium chloride** by the mouth, coagulability being much increased thereby for an hour to an hour and a half. The effects become evident in a few minutes. If the tendency to hemorrhage returns later, the dose of salt is repeated, or **potassium bromide** substituted in the dose of 45 grains (3 Gm.), the bromide having, further, a sedative action. In the most urgent cases the use of sodium chloride and potassium bromide, in full doses, may be combined. R. von den Velden (*Deut. med. Woch.*, Feb. 4, 1909).

In **capillary hemorrhages**, including **capillary hemoptysis**, in the **hemorrhagic diathesis**, and in **epistaxis** and **metrorrhagia**, Reverdin claims 2-grain (0.13 Gm.) doses of sodium sulphate every hour to be of great value. The drug must be given by mouth or intravenously, not hypodermically. It is believed by him to increase the coagulability of the blood.

In **acute tonsillitis, catarrhal conditions, bronchitis**, etc., sodium bicar-

bonate in solution may be combined with hamamelis, belladonna, or other remedial agent. According to Bulkley, **coryza** may be successfully treated by giving 20 to 30 grains (1.3 to 2 Gm.) of the sodium bicarbonate in 2 or 3 ounces (60 or 90 c.c.) of water, every half-hour, for three doses, with a fourth dose an hour from the last one. Two to four hours are next allowed to elapse, and the four doses are then repeated if there seems to be necessity, as is frequently the case. After waiting two to four hours more the same course may be taken again. To be promptly effective the measure should be begun with the earliest indications of coryza and sneezing, when it rarely fails to break up the cold.

K. E. Kellogg points out that in **hay fever** marked relief from the rhinitis symptoms follows the taking of sodium bicarbonate in 1-dram (4 Gm.) doses three times a day. The drug appears to have a desensitizing action on the mucous membranes. In a few cases he found it necessary to supplement the treatment with a nasal spray of sodium bicarbonate solution.

In affections of the throat and fauces, sodium chlorate is a better and safer remedy than the potassium salt.

In **malignant forms of sore throat** and in **diphtheria** the official solution of chlorinated soda ($\frac{1}{2}$ to 2 drams—2 to 8 Gm.—in water, 4 to 8 ounces—120 to 240 c.c.) has been used as a gargle. Sodium sulphite in solution (1 to 8) may be used as a gargle, spray, or local application in similar conditions. It has also been used internally in combination with sulphur and calomel.

Solutions of sodium bicarbonate are extensively used in **catarrhal conditions** to soften and remove dried secretions and thickened mucus. *Do-bell's solution* (sodium bicarbonate and borax, of each, 2 drams—8 Gm.; phenol, 24 grains—1.5 Gm.; glycerin, 14 drams—56 Gm.; water, 1 pint—500 c.c.) is largely used for this purpose. Pyncheon has recommended the following as better: Sodium bicarbonate and borax, of each, 2 ounces (60 Gm.); listerin (liquor antisepticus, U. S. P.), 8 ounces (240 c.c.); glycerin, $1\frac{1}{2}$ pints (750 c.c.); of this add 1 ounce (30 Gm.) to 1 pint (500 c.c.) of water.

Gynecological and Puerperal Disorders.—**Leucorrhea**, when dependent upon an increased secretion of the cervical glands, frequently yields to injections of a 1 per cent. solution of the bicarbonate. This secretion is strongly alkaline, and is checked on the general principle that alkalies check alkaline secretions.

In **puerperal metritis** the solution of chlorinated soda (1 part to 10 or 12 of water) has been used as an antiseptic injection. In the same strength it may be used as a vaginal douche when the lochial discharge becomes fetid. It is also a useful injection in simple and gonorrheal vaginitis.

A hypertonic solution of 4 drams (16 Gm.) of sodium chloride and $\frac{1}{2}$ dram. (2 Gm.) of sodium citrate to the pint (500 c.c.) of water proved an effective vaginal douche in all **inflammatory diseases of women** and in **septic conditions**, giving better results than the customary antiseptic douches. In infected puerperal lesions of the genital tract healthy granulation was secured in a few days. After clearing out the uterus in **puerperal sepsis** and douching it

with the hypertonic saline solution, a few tablets of salt left in the uterine cavity cause the flooding of any remaining organisms with the serum drawn out to dissolve the salt and materially hasten recovery. All conditions producing **pelvic congestion** responded well to the hypertonic douches. Enemata of water containing from 3 to 6 or 8 drams (12 to 24 or 32 Gm.) of salt to the pint (500 c.c.) proved effective in emptying the bowel in **eclampsia** and other conditions requiring a watery evacuation for the removal of toxic material. Clifford White (Lancet, Oct. 30, 1915).

Constitutional Disorders. — Acute rheumatism, though usually best treated with the salicylates (see **SALICYLIC ACID**), is also amenable to the action of the alkalis. Sodium bicarbonate is of great service in allaying the pain and soreness of the joints when given internally in doses of from 15 to 30 grains (1 to 2 Gm.) every four hours. It may also be used in solution as a lotion, applied around the joints on lint or cloths. Sodium nitrate in solution (1 to 3) has been used externally in like manner. Sodium acetate has been given in **acute rehumatism** and **gout**, but its value is less than that of the corresponding potassium salt.

In conditions associated with **acidosis**, including **diabetes mellitus**, sodium bicarbonate or carbonate have been extensively used. To act as a blood alkalinizer sodium bicarbonate should be given shortly before meals, when no acid to neutralize it is present in the stomach. In **diabetic coma**, **delayed chloroform poisoning**, and similar severe states of acidosis, doses as large as ½ ounce (15 Gm.) of the bicarbonate have been given by mouth, or by the rectal drop method,

amounts up to 1½ ounces (50 Gm.) a day, in a 3 per cent. solution in water. At times, gratifying results have been obtained.

Sodium citrate advocated in place of sodium bicarbonate for use in **acidosis**. It is practically tasteless, and may be added to the food or given in water and lemon-juice. Although the author has given as much as 1½ ounces (45 Gm.) a day, it causes much less digestive disturbance than the bicarbonate, and diarrhea never followed its administration. Lichtwitz (Therap. Monat., xxv, nu. 81, 1911).

The hypodermic use of sodium bicarbonate solutions has fallen into disrepute on account of their extremely irritating properties. This is because during sterilization this salt is largely converted into sodium carbonate. The latter may be reconverted into sodium bicarbonate if carbonic acid gas is allowed to bubble through the sterilized solution. The latter is then well borne both subcutaneously and intravenously, and is indicated in **diabetic coma**. A 4 per cent. solution should be used. The writer advocates the preparation of such solutions in sealed flasks with a carbonic acid atmosphere. Magnus-Levy (Med. Klinik, S. 2001, 1914).

Vorschütz has called attention to the value of an alkali in whipping up the body cells to proper metabolism and elaboration of protective substances. A deficiency of alkali, he asserts, may be responsible for defective antibody production. In cases with severe **septic processes**, **osteomyelitis**, **scarlatinal nephritis** with **abscess**, etc., he witnessed good effects from having the patients drink during the day a bottle of Seltzer-water, in which 150 to 300 grains (10 to 20 Gm.) of sodium bicarbonate had been dissolved. Although in some

cases gastric discomfort necessitated at times suspension of the treatment for a day or two, some patients took the doses mentioned for weeks without disturbance, and all cases thus treated recovered.

Surgical Disorders.—In fractures and sprains a solution of sodium silicate constitutes a valuable dressing, as it rapidly becomes hard and immovable when painted over the bandages and thus forms an immovable splint which is cleaner than plaster of Paris and equally effective.

Morbid growths, warts, etc., may be removed by applications of caustic soda or of London paste.

Wright's solution, composed of 4 per cent. sodium chloride and 1 per cent. sodium citrate in water, is useful in the treatment of **infected wounds, abscesses, etc.** The citrate, by precipitating the calcium salts in the lymph, prevents coagulation and insures free exit of lymph discharge. The chloride, in hypertonic solution, hastens the flow of lymph by osmosis, thus antagonizing bacterial development, and is itself antiseptic owing to its hypertonicity.

In using Wright's solution for drainage, the abscess is opened by a wound as small as will allow the cavity to be wiped out, or thoroughly emptied by expression. The surrounding skin is thoroughly cleaned with 70 per cent. alcohol and smeared with boric acid or eucalyptus petrolatum. If the skin tension closes the lips of the wound a bit of rubber dam may be put in. The wound is covered with a large pad of gauze or of absorbent cotton covered with gauze, dripping wet with hot salt and sodium citrate solution. The part is put at rest. Outside the dressing may be applied a hot flaxseed poultice or a hot-water bottle. As often as the dressing gets

cold more of the hot solution is poured over the whole dressing. The solution is contraindicated if there is a tendency to persistent oozing of blood from the wound, and when protective adhesions are desirable, as in certain abdominal wounds just after operation. The solution should be used only for the first thirty-six to seventy-two hours after operation, during the acute stage of the inflammation. If used longer it leads to maceration and indolence in healing. L. R. G. Crandon (*Annals of Surg.*, Oct., 1910).

Wright's citrated isotonic solution (sodium citrate, 0.5; sodium chloride, 3.0; distilled water, 100) used with great satisfaction in the treatment of **wounds**. G. K. Dickinson (*Med. Rec.*, June 20, 1914).

Foul ulcers, sinuses, etc., may be cleansed with liquor sodæ chlorinatæ, diluted in the proportion of $\frac{1}{2}$ to 4 drams (2 to 16 c.c.) to 8 ounces (250 c.c.) of water. In military practice a $\frac{1}{2}$ per cent. solution of sodium hypochlorite has been extensively used for checking **infection in wounds**. *Dakin's solution* is prepared by dissolving, in 10 liters (quarts) of tap-water, 140 Gm. ($4\frac{1}{2}$ ounces) of dried sodium carbonate (or 400 Gm.—13 ounces—of the crystalline salt) and 200 Gm. ($6\frac{2}{3}$ ounces) of good quality calcium chloride. The mixture is well shaken up and after half an hour the clear liquid separated by siphonage, filtered through cotton, and 40 Gm. ($1\frac{1}{3}$ ounces) of boric acid added. In *Carrel's technique* of wound treatment, rubber tubes surrounded by an absorbent, spongy material are carried to the bottom of the wound and in each of its recesses, and Dakin's solution is injected into the tubes at one or two-hour intervals, or, better, introduced by continuous instillation by the drop method.

Intravenous infusion of 3 to 5 c.c. (48 to 80 minims) of a 5 per cent. salt solution practised with the best results before operations in which parenchymatous hemorrhage is feared or when the blood coagulates less readily than normal. The measure is advised in prophylaxis or during the operation, repeating it every half-hour as needed. Von den Velden (Zentralbl. f. Chir., May 21, 1910).

Instruments, especially if plated, when boiled in a solution of sodium carbonate or bicarbonate come out covered with a white scum, are slippery, and less quickly dried, and are likely to turn black, especially if they have any blood left on them. The writer recommends, instead, the use of sodium hydroxide, which has not these disadvantages. About 38 grains (2.5 Gm.) or $\frac{3}{4}$ inch of stick caustic to a quart (liter) of water makes the proper solution. I. M. Heller (Jour. Amer. Med. Assoc., Aug. 26, 1911).

CHLORIDES IN URINE.—These consist chiefly of sodium chloride, with a small amount of potassium and ammonium chlorides. The healthy adult excretes from 10 to 16 grams of chlorides in 24 hours. The chlorides are *increased* normally, by increased ingestion of salt, by abundant drinking of water, and by active exercise; abnormally, in the first few days after the crisis of acute febrile diseases, gradually increasing as the disease abates; in diabetes insipidus; in dropsy after diuresis has set in. The chlorides are *decreased* normally during repose; abnormally, in all acute febrile conditions (especially with serous exudations) up to the crisis, when they may disappear; in pneumonia their absence always indicates a serious condition; in diarrhea; in chronic conditions with impaired digestion and dropsy; during the formation of large exudations; in acute and chronic diseases of the kidneys with albuminuria; in chronic diseases. A decided diminution or absence of chlorides in a febrile condition strongly suggests pneumonia.

Test for Chlorides.—Place 2 drams of urine in a test-tube, acidify with 10 or 12 drops of nitric acid, C. P., and carefully add 1 drop of silver nitrate solution

(1 to 8). If the amount of chlorides be about normal, this drop will form a whitish globule, a solid white ring or one or more compact, whitish, flocculent lumps, and will settle to the bottom. If the chlorides are diminished, there will be only some cloudiness. One may use a specimen of normal urine in another test-tube as control. When the exact quantity of chlorides is desired, one must resort to quantitative titration, the technique of which may be found in larger treatises on Urinalysis.

SALINE SOLUTION.—Preparation.—As ordinarily prepared, "normal" saline solution is of 0.8 to 0.9 per cent. strength. For the preparation of a sterile solution of this type, sterile sodium chloride may be dissolved in sterile water in the ratio of 1 dram (4 Gm.) of the salt to 1 pint (roughly 500 c.c.) of water; or, the solution may be sterilized after the salt has been dissolved. The solution should then be filtered into flasks, and these plugged with non-absorbent cotton and sterilized *in toto*.

Hypertonic sodium chloride solutions are at times used, as in the hypertonic saline treatment of Asiatic cholera devised by Rogers, in which 1.2 or 1.6 per cent. solutions of the salt are employed. (See CHOLERA.)

Physiological Action and Uses.—Introduction of normal saline solution into the system may be of value in a variety of ways. In hemorrhage and in depleted states, such as that arising in cholera, it is of assistance to restore the blood volume to normal, thereby not only favoring better distribution of blood to the peripheral parts of the body, but also improving heart action by allowing the organ to contract under more normal mechanical conditions. In toxemic states, saline solution is of value to promote renal activity and therewith

elimination of toxic material. Where the blood-pressure is low, a small saline infusion containing a moderate amount of epinephrin is of great value, though unless the administration be continued the effect soon wears off through filtration of the solution from the vessels into the tissues. (Large saline infusions under these conditions merely favor the production of edema.) Saline infusions are also of value for the relief of thirst.

Absorption of saline solution, however given, is generally rapid. In saline hypodermoclysis a pint of solution may be absorbed within ten or fifteen minutes, though at times marked circulatory weakness greatly delays the process. After hemorrhage, especially rapid absorption occurs from the bowel.

Modes of Administration.—Among the various routes available are: (1) the rectal; (2) the subcutaneous; (3) the intravenous; and (4) the intraperitoneal.

(1) **Saline enteroclysis** (proctoclysis; rectal infusion) is advantageous in that the slight pain entailed in the insertion of a needle through the skin is avoided, and that the use of a sterile solution is not necessary. The older method of applying the procedure consists merely in passing into the rectum a pint to a quart of saline solution at 110° F. through a small catheter, twenty to thirty minutes being allowed for its entrance into the bowel. The measure may be repeated at four-hour intervals as long as the necessity for saline administration persists. An improved procedure is that recommended by John B. Murphy, in which precise adjustment of the flow of saline solution to the absorptive

power of the bowel is sought. An excellent description of **Murphy's technique of proctoclysis**, kindly furnished us by Dr. Richard L. Stoddard, of Rochester, N. Y., is subjoined:—

Cleansing enemas, to the extent of emptying the intestinal tract of fecal matter, are necessary before beginning the proctoclysis treatment. Thorough elimination of all formed feces from the intestinal tract during the preoperative preparation is of paramount importance.

The saline solution is made by adding 1 dram (4 Gm.) each of sodium chloride and calcium chloride to each pint (500 c.c.) of hot water. The solution must be maintained at a temperature *per rectum* of 100° to 110° F.

The average quantity is 1½ to 2 pints (250 to 1000 c.c.) every two hours. The quantity to be given depends upon the severity of the case, the age of the patient, and the development of an edema. The average twenty-four-hour quantity is 18 pints. In a child of 11 years (a patient of Dr. Murphy's) 30 pints were administered in twenty-four hours. Murphy states that "less than 8 pints in twenty-four hours is of very little value from a therapeutic standpoint."

The base of the saline solution container should be elevated sufficiently—2, 4, or 6 inches—above the buttocks of the patient to allow 1½ to 2 pints of the solution to flow into the rectum in from forty to sixty minutes. The rapidity of the flow should never be controlled by the use of forceps, clamps, knots, or faucets, in connection with the tubing. The height of the container must always control the hydrostatic pressure, which should average 4 to 6 inches, and not exceed 15 inches.

The patient is placed in the Fowler position, and the proctoclysis continued for two or three days, and sometimes five or six days. Too much solution after the third, fourth, or fifth day is indicated by edema of the ankles, hands, and even the face, and occasionally by threatened heart-failure. The solution should then be discontinued until the circulatory equilibrium is restored, when the treatment may be

repeated if indicated. The Fowler position, being uncomfortable for many patients, need be used only in exceptional cases where abdominal drainage is necessary for twenty-four to forty-eighth hours. An excellent and comfortable substitute for the Fowler position is to raise the head of the bed 12 to 18 inches.

A medium-sized hard-rubber vaginal douche tube, with several $\frac{1}{8}$ - to $\frac{1}{4}$ -inch openings, makes a useful rectal tube, which must be flexed at an obtuse angle 2 or 3 inches from its tip. The rectal tube will cause no inconvenience if so strapped to the thigh as not to press on the posterior wall of the rectum. Frequent changing of the rectal tube, as removing and inserting, or an improper position of the tube, or a too rapid flow of the solution into the rectum, are each and all very annoying to the patient, and soon produce an irritation of both the anus and rectum, resulting in partial or complete evacuation of the saline solution.

When the patient strains during the act of vomiting, coughing, or sneezing, or wishes to expel gas or fluid, provision should always be made for a sudden return of the fluid through the rectal tube and rubber tubing into the saline solution. For this important purpose, one should use a medium-sized rectal tube with the openings as described; avoid attempting to control or govern the rapidity of the flow by the use of clamps or faucets, and also avoid overdoing the hydrostatic pressure.

If the rectum is not in an irritated condition from surgical interference, or otherwise, success in the early administration of large quantities of saline solution will be had with the above technique.

In case an elaborate and electrically heated solution container is not at hand, an ordinary douche-can may be employed, and may be maintained at the desired temperature by first immersing a bath thermometer in the saline solution, and then surrounding the container with bottles filled with boiling water, or immersing one or two bottles in the solution. To further retain the heat, the whole apparatus, bottles and container, may be wrapped in a warm woolen blanket. By immersing a 16-candle-power electric-light

globe and a thermometer in the saline solution, the desired temperature can be more easily maintained.

For the past three years Dr. Stoddard has been using the Nylander electric saline heater, which correctly regulates the temperature. He has thoroughly tested the Murphy method of proctoclysis in **peritonitis, typhoid, uremia, diphtheria, pneumonia, shock from hemorrhage**, and local and general **septicemia**, and has found it of inestimable value, especially if used early and before the heart has been badly affected by the intoxication.

In **lobar pneumonia** proctoclysis with hot tap-water was usually followed in a few hours by abatement of the signs of toxemia and mental improvement. In **typhoid fever** benefit was also noted. In obstinate cases of **delirium tremens** the mental state rapidly cleared up. In 4 cases of **scarlet fever**, 2 very severe, excellent results were obtained. The casts and albumin found in the urine early in the disease disappeared before the patients left their beds. In the intercurrent febrile, "grippal" attacks of **pulmonary tuberculosis**, the comfort of the patient was greatly increased and the invasion apparently cut short. In the sudden flooding of the system with toxins from confined pus which not rarely occurs in tuberculous subjects, remarkable amelioration of the symptoms may follow saline proctoclysis. Henry Sewall (Amer. Jour. Med. Sci., Oct., 1910).

All patients show less rectal irritation to proctoclysis if given a saline enema before the operation. Patients given water by rectum absorb nearly 400 c.c. more in the twenty-four hours than do patients given salt solution, the average for the former being 2444 c.c., and for the latter 2041 c.c. Patients given salt solution by rectum require nearly twice as much water by mouth to relieve thirst—696 c.c. in the first twenty-four hours, as against 332 c.c. The

amount of urine is practically the same in the two classes of cases. In drainage cases more fluid may be taken by rectum than in laparotomies closed without drainage. Proctoclysis should be employed more frequently, and in all classes of cases in which it is possible. Care should be taken to prevent "water-logging" of the system, this applying to both salt and water. In peritonitis cases with drainage, the patient can take four or five times as much fluid by rectum as in other conditions. H. H. Trout (Jour. Amer. Med. Assoc., May 4, 1912).

A new device which consists in placing a two-quart heating bag near the patient's rectum, through which the salt solution pipe passes as in a hot-water bath, prevents the great loss of heat from the tube, as in other methods. In this method the temperature of the saline as it enters the rectum at first, when the heating bag has just been filled, is about 108° F., from which it drops gradually in an hour and a half to 98°, when the heating bag is refilled at 140° F. and the rectal temperature returns to 108° F. G. H. Tuttle (Inter. Jour. of Surg., June, 1913).

Proctoclysis method applied to infants in place of subcutaneous saline injection. Tolerance was perfect, even in the youngest. Fifty or 100 c.c. of isotonic saline solution or 4 per cent. solution of sugar is absorbed as rapidly as by subcutaneous injection. Excellent results obtained in children of all ages with **gastro-enteritis, cyclic vomiting, acute alimentary anaphylaxis, and typhoid fever**. In some cases a little epinephrin was added. The latter was more effectual by rectum than by mouth. Lesné (Bull. de la Soc. de Pédiat., Oct., 1913).

Saline proctoclysis by the drop method gives in **typhoid fever** results as good as, if not superior to, those of the cold-bath treatment. In the lung complications of typhoid fever, dyspnea is relieved and the physical

signs of lung condensation caused to disappear by the measure. Even in acute, frank **pneumonia**, the procedure at once reduces the dyspnea and liquefies the secretions. The heart is quieted, marked diuresis supervenes, and the crisis ordinarily occurs on the fifth day, though the physical signs persist a few days longer. P. E. Weil (Presse méd., Feb. 14, 1916).

(2) **Saline hypodermoclysis** (subcutaneous infusion), while usually highly efficient, is somewhat painful. Careful asepsis is required, and care must be taken not to introduce too much solution in a single area, lest the prolonged anemia of the tissues result in their devitalization and sloughing. The method is especially indicated where the emergency is not such as to require intravenous infusion but the rectal route is unavailable because the bowel is too irritable or for some other reason.

Hypodermoclysis may be practised under the breast, in the loose tissue over the pectoral muscle, on the posterior or inner aspects of the thighs, beneath the abdominal skin, including the ilio-lumbar regions, or between the scapulae. The reservoir for the solution is usually of glass, preferably graduated. The needle should be long and preferably of a large caliber, such as 1 to 2 millimeters, for although a small hypodermic needle may be successfully used, greater hydrostatic pressure is then required and the solution cools more as it descends through the tube, necessitating an original temperature of 110° C., as against 105° C. if the aspirating needle is used. The entire apparatus should have been sterilized. Before the infusion is given, the breast, in the case of women, is carefully disinfected. It is then raised, and the needle, with the fluid flowing from it, gently inserted into the cellular tissue beneath the organ. The pain of the puncture may be avoided with ethyl chloride. Where elevation of the reservoir is insufficient to maintain the flow, or the latter stops some

time after, withdrawing the needle slightly or rotating it will usually start the stream again. If not, the fluid can be forced in by anointing one hand and the tube with petrolatum, and stripping the tube downward between the fingers. Seven hundred cubic centimeters of fluid (1½ pints) can be injected under each breast. After completion of the procedure the puncture can be closed with rubber tissue or adhesive plaster.

Absorption from hypodermoclysis where the general circulation is markedly impaired can be hastened by the addition, where possible, of enteroclysis, or even a simple hot saline enema (R. C. Kemp). Gentle local massage also hastens it.

Salt solution for therapeutic purposes may be injected into the pre-vesical space of Retzius. This space is roomy, the connective tissue is loose, and can easily hold one liter (quart) of solution. The needle is inserted just above the symphysis pubis, and pushed along the rear wall of the latter. In a large experience, puncture of the bladder never occurred. The author uses a fairly large needle. One is thus able to inject a liter of solution in eight to nine minutes. D. Schoute (Zentralbl. f. Chir., July 6, 1912).

For hypodermoclysis the writer uses a large silver cannula from a Southey tube apparatus, connected with a large glass funnel by means of a tapered glass tube and a section of Southey's rubber tubing. This is all readily portable and readily sterilized by boiling. In administering the saline the anterior axillary fold is grasped firmly and drawn outward. The trocar with cannula is then passed into the skin in a direction perpendicular to the chest and pushed through the axillary fold, so that its point emerges within the axilla. The trocar is then removed and the cannula is pushed outward until its shoulder is flush with the skin. The fluid emerging from this cannula squirts in all directions. It is absorbed so rapidly that one can inject a quart into the tissues in

twenty minutes without any material swelling occurring. E. M. Woodman (Brit. Med. Jour., Feb. 8, 1913).

(3) **Intravenous saline infusion** is indicated in the more urgent emergencies, *e. g.*, after very abundant hemorrhage; in cases of **shock**; where prompt elimination of toxic material from the blood is desired, as in **delirium tremens**, **gas poisoning**, and **septicemia**, and where **anuria** has developed, the rise in blood-pressure attending intravenous infusion causing a resumption of renal function.

The apparatus required comprises some species of graduated reservoir for the saline solution, a connecting rubber tube with pinchcock, and a cannula for insertion into the vessel. A slightly curved cannula is to be preferred, facilitating maintenance in the lumen of the vessel. In emergencies the glass portion of a medicine dropper may be substituted. As in hypodermoclysis, the apparatus and solution used should be sterile. The normal saline solution should be placed in the reservoir at a temperature of 120° F. Another useful form of apparatus comprises a large flask, arranged like the ordinary wash bottle, with two glass tubes, one short and the other long, entering it through the stopper. The longer glass tube, dipping into the contained saline solution, is connected by tubing with the infusion cannula, while to the other tube a rubber pressure bulb is attached. Pressure upon this bulb forces air into the flask, and hence the saline solution into the vein. The temperature of the solution in the flask may be maintained by placing it in a large jar partly filled with hot water.

Preparation of the patient consists in placing a constricting bandage around the upper arm, tightly enough to obstruct the venous return flow, thus distending and rendering easily visible the vein to be employed, usually the median basilic or median cephalic at the bend of the elbow, applying alcohol or tincture of iodine at the latter area, and exposing the vein, under aseptic precautions, for a distance

of about one inch. After passing two ligatures, untied, round the vessel, a small valve-shaped opening, the flap of vessel raised pointing distally, is made with pointed scissors, and the cannula, well filled with solution and free of air-bubbles, passed into the opening. The cannula is now fixed in the vessel by tying the upper ligature, the low ligature also tied to close the vein below, and the constricting band round the arm removed. The saline solution receptacle should be at such an altitude, usually about three feet, above the vein that the solution will run in but slowly. The heart and blood-pressure should be watched, care being taken not to dilate and weaken the former or to raise the latter excessively by infusing too much solution. The usual amount is 1 to 3 pints (500 to 1500 c.c.). In **shock** injection of 1:1000 epinephrin solution with a hypodermic syringe into the lumen of the rubber connecting tube may be advantageous. This should be done slowly, a few drops being given every few minutes until the desired rise in blood-pressure has been obtained. Another good procedure is to drop the epinephrin, according to requirements, in a funnel into which the saline solution is being poured at intervals as it is consumed.

Many users of intravenous saline therapy simplify the insertion of the needle by dispensing with exposure of the vein, the needle, with an obtuse angle point, being merely thrust obliquely into the distended vessel while the solution is flowing. The point of the needle should not be too sharp, to avoid inadvertent injury to the vessel's walls after its insertion, and should be held firmly in proper relation to the vein while the saline solution is being run in.

(4) **Intraperitoneal saline infusion** is of value at the termination of abdominal operations attended with marked **shock**, provided extension of an intra-abdominal infection as a result is not apprehended. J. G. Clark found that flushing the peritoneum with the solution greatly augmented leucocytosis, and advocates its use

even in peritoneal infections. He makes it a practice to leave at least 1 liter of solution in the peritoneal cavity even after the simplest operations, not only the circulation, but also the kidneys, skin, intestines, and all other organs functioning better under its influence, thirst being relieved, and the virulence of infection being decreased.

Contraindications.—Saline infusions are contraindicated in many instances of edema, especially where there is retention of sodium chloride in the system as a result of renal impairment, and in pulmonary edema. Pure salt solution often fails to bring on diuresis in cholemic states, probably because of a prejudicial action of the circulating bile on the kidneys.

Other Solutions.—The studies of Jacques Loeb have shown that a solution of pure sodium chloride in distilled water has poisonous properties owing to the complete absence of other salts, especially those of calcium and potassium. As the tap-water generally employed in the preparation of normal saline solution is likely to contain some calcium salts, but little of which is required to offset the poisonous influence of the sodium, no difficulty from the use of the ordinary normal saline solution is, as a rule, experienced. The possibility of danger from excessive displacement by sodium chloride of the calcium and potassium salts known to be essential to the vitality of the body cells is recognized, and Thies has advised against the use of pure normal sodium chloride solution, especially in small children with disorders associated with a considerable elimination of salts, in inanition from pyloric stenosis or other cause, in cachexia,

in conditions entailing changes in the kidneys or cardiovascular system, and in febrile affections, in which elimination of salts other than those of sodium is augmented. Thies recommends for rectal introduction a solution containing 0.6 per cent. of sodium chloride and 0.02 per cent. each of calcium chloride and potassium chloride, and for hypodermoclysis, one containing 0.85 per cent. of sodium chloride and 0.03 per cent. each of the other salts. Among other improved substitutes for normal sodium chloride solution are:—

Dawson's solution, containing 0.8 per cent. of sodium chloride with 0.5 per cent. of sodium bicarbonate.

Locke's solution: Sodium chloride, 0.9 per cent.; potassium chloride, 0.042 per cent.; calcium chloride, 0.024; sodium bicarbonate, 0.03, and dextrose (glucose), 0.1 in distilled water. (Schiassi would reduce the potassium salt to 0.0075 and the calcium salt and bicarbonate each to 0.01.)

The *Ringer-Locke solution*, like the preceding, but with the nutrient dextrose omitted.

Fleig's solution: Sodium chloride, 0.65 per cent.; potassium chloride and magnesium sulphate, of each 0.03; calcium chloride, 0.02; sodium bicarbonate, sodium glycerophosphate, and dextrose, of each 0.1, in distilled water. Oxygen, *ad saturandum*, may with advantage be added.

H. M. Adler's solution: Sodium chloride, 0.59 per cent.; potassium and calcium chlorides, of each 0.04; magnesium chloride, 0.025; sodium dihydrogen phosphate, 0.0126; sodium bicarbonate, 0.351, and glucose, 0.15. This solution, on one occasion, maintained rhythmic contractions of an isolated cat's heart for twenty-one hours, and is intended to provide a mechanism for maintaining the reaction of the blood, for neutralizing acids and alkalies, and for the transport of a sufficiently large amount of carbon dioxide.

Fischer's solution, containing 1.4 per cent. of sodium chloride and 1 per cent. of crystallized sodium carbonate, has been recommended by W. M. Brown for rectal

or oral introduction in **puerperal eclampsia** to maintain a proper circulatory volume after eliminative treatment by catharsis, hot packs, colon irrigations, or venesection.

Fischer's solution used in a case of **vomiting of pregnancy** where other measures had failed, giving 20 grains (1.3 Gm.) of sodium bromide dissolved in a pint (500 c.c.) of this solution per rectum by the drop method. A patient with **chronic myocarditis**, **mitral regurgitation**, and a moderate degree of **arteriosclerosis**, with general edema and vomiting, was put on Fischer's solution per rectum by the drop method and passed a gallon of urine inside of fourteen hours. **Post-partum eclampsia**, coming on in a primipara who failed to respond to the ordinary treatment, was successfully treated by venesection, followed by intravenous infusion of 1½ pints (750 c.c.) of Fischer's solution. Southworth (*Lancet-Clinic*, Sept. 5, 1914).

A study of **antianaphylactic immunization** with sodium chloride showed that when a second injection of horse serum is to be given to an animal which 3 weeks previously had been given a preliminary injection of this serum, the violent anaphylactic reaction, which is frequently lethal within a short time, may be prevented by the use of a serum which has been diluted with 9 times its volume of isotonic sodium chloride solution. Where this is done the reaction is of only moderate intensity, and the animal quickly recovers. If the solution is injected before the serum a much larger quantity of salt is required. Richet, Brodin and Saint-Girond (*Presse méd.*, July 24, 1919).

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SPIGELIA.—*Spigelia* (pink-root; Maryland, Carolina, or Indian pink; worm-grass, worm-weed, starbloom) is the dried rhizome and roots of *Spigelia marilandica* (fam., Loganiacæ), growing in thickets from Pennsylvania to Illinois and southward. The active constituent is

apparently a volatile, crystallizable alkaloid, spigeline, which is soluble in both alcohol and water. There is also present a small amount of volatile oil, fat, wax, tannin, and a tasteless resin.

PREPARATIONS AND DOSES.—

Spigelia, U. S. P. (*spigelia*). Dose of powder, 10 to 20 grains (0.60 to 1.30 Gm.) to a child under 5 years of age, and from $\frac{1}{2}$ to 2 drams (2 to 8 Gm.) to an adult.

Fluidextractum spigeliae, U. S. P. (fluid-extract of *spigelia*). Dose, 10 to 20 grains (0.60 to 1.30 c.c.) to a child of 5 years, and from $\frac{1}{2}$ to 2 drams (2 to 8 c.c.) to an adult.

The fluidextract of *spigelia* and senna, formerly official, is a convenient and active preparation, and may be given in the same dose as the official fluidextract of *spigelia*, preferably in simple syrup, or with aromatics.

PHYSIOLOGICAL ACTION.—*Spigelia* is a popular and efficient anthelmintic against roundworms (*Ascaris lumbricoides*). It has some cathartic action, but as this is uncertain it is usually combined with senna, Epsom salt, or other cathartic. When purgation is lacking or tardy cerebral symptoms may present, as vertigo, dimness of vision, strabismus, mydriasis, and even convulsions.

POISONING BY SPIGELIA.—Toxic doses produce a hot, dry skin and fauces, accelerated circulation, dilated pupils, internal strabismus, exophthalmos, general motor paralysis, drowsiness, passing into coma and slow respiration. Death occurs from paralysis of the respiratory center.

THERAPEUTIC USES.—*Spigelia* is chiefly useful as an anthelmintic against roundworms (*Ascaris lumbricoides*) and ranks as one of the best. It is always best to administer a dose of a saline, like magnesium citrate or sulphate, about two hours after taking *spigelia*. W.

SPINAL ANESTHESIA.—In spinal anesthesia, or analgesia, or, better, *subarachnoid anesthesia*, insensibility of portions of the body is produced by the injection of local anesthetic drugs into the subarach-

noid space in the spinal canal. The method may more properly be termed a nerve-root than a spinal anesthesia, since it is the sensory nerve-roots as they meet the spinal cord, rather than the cord itself, which are anesthetized. The term *lumbar anesthesia*, sometimes used, applies definitely to anesthesia induced by injection in the lumbar portion of the spinal column. *Sacral* or *caudal anesthesia* is to be clearly differentiated from the usual type of spinal anesthesia, in that the anesthetizing injection is made, not into the subarachnoid space, but in the sacral canal below and outside the dura covering the nerve-trunks of the cauda equina. This procedure will be taken up in a separate section at the close of this article.

To J. Leonard Corning, of New York, belongs the credit of first applying the principle of conduction anesthesia to the structures enclosed in the spinal canal. In 1888 spinal (extradural) injections of cocaine were made by him for the relief of pain in 4 cases of spinal disease, but it was not until 1899 that actual intradural anesthesia with cocaine was attempted by August Bier, of Bonn. Others soon adopted the procedure, often only to abandon it later owing to the unpleasant and at times fatal results attending the use of cocaine. In 1904 a long step forward was made in the substitution for cocaine of the less toxic stovaine, discovered by Fournau in the preceding year. Numerous further improvements in the technique since that time have done much to popularize the procedure, and have reduced its disadvantages as compared to other major forms of anesthesia—practically to the vanishing point.

PHYSIOLOGICAL ACTION.—

The action of the various drugs which have been used in spinal anesthesia is so similar that a single description will answer for all. The spinal cord occupying less than one-half the anteroposterior and transverse diameters of the spinal canal, a considerable space, filled with cerebrospinal fluid, exists between it and the surrounding arachnoid and dural membranes. An anesthetic drug injected into this space comes in contact, not only with the spinal cord, but with the motor and sensory nerve-roots, the conductive power of which it arrests, causing anesthesia, motor paralysis, and sympathetic paralysis in the segments involved. The spinal cord itself is but superficially influenced, and its columns may continue their functional activity during the anesthesia. The autonomic system, likewise, remains practically uninfluenced.

The action of the drug begins in a few seconds after its injection, and the patient immediately notices a paresthesia of the feet, followed very promptly by insensibility and almost complete motor paralysis. The pain sense is more markedly and extensively paralyzed than the tactile sense; thus, if the anesthesia be not deep, the contact of the knife during the incision may be felt, though no pain is experienced. Sensation is lost before the power of motion, which may therefore persist during the analgesia if a weak solution of the anesthetic is used. With sufficient dosage, however, the patient becomes completely unaware of the position or movements of the lower limbs.

The duration of the analgesia varies markedly with the dose and con-

centration of the drug used, ranging from as little as twelve minutes to two hours. After the full adult dose the average duration of analgesia is from one to one and a half hours, the effect beginning slowly to recede from its maximum fifteen or twenty minutes after the injection. Whereas 0.05 or 0.06 Gm. ($\frac{3}{4}$ to 1 grain) of stovaine in 4 per cent. solution will produce an analgesia lasting about ninety minutes, the effect from a 0.02 or 0.03 Gm. ($\frac{1}{3}$ to $\frac{1}{2}$ grain) dose in the same concentration will persist only fifteen or twenty minutes.

The abdominal walls being relaxed in spinal anesthesia, the abdomen becomes partially scaphoid, and abdominal breathing, except from the diaphragm, is practically abolished. The intestine is largely released from sympathetic inhibition through paralysis of the rami communicantes, and tends, therefore, to contract, the gaseous and liquid contents of the large intestine not infrequently escaping—an advantage in ileus—as the anal sphincters are simultaneously relaxed. Peristalsis is, to a slight extent, similarly stimulated in the stomach. Where the upper dorsal or cervical segments become involved in the anesthetic action, nausea, usually very transient, and caused probably by cerebral anemia, is frequently experienced. Vomiting is difficult unless the head and chest be lowered.

The effect of spinal anesthesia on the circulation is to produce a reduction in the pulse rate and blood-pressure, which is proportionate to the intensity of the anesthesia, and, in particular, to its height in the spinal canal. Where only the lower spinal segments are involved these changes are likely to be but slight, but if the

upper dorsal nerve-roots are reached the pulse rate may drop to 40 or 30, and the blood-pressure to zero at the wrists. These effects, which may be ascribed to vasomotor paralysis in the involved segments, to absence of opposition to cardioinhibitory vagal activity owing to paresis of the sympathetic accelerator mechanism, and probably to other factors, begin in about fifteen or twenty minutes after the injection, and gradually subside after a time. No other anesthetic induces so complete a vasomotor relaxation, though if the breathing is well maintained, even a zero blood-pressure at the wrist may be innocuous.

Respiration is affected, even in anesthesia limited to the lower dorsal segments, in that the co-ordinate movements of the abdominal walls are lost, the respirations becoming exclusively diaphragmatic. If the action extends sufficiently high to relax the chest walls, a sense of weight or thoracic oppression may be experienced, and if the fourth cervical segments supplying the phrenics are reached, progressive asphyxia rapidly follows, unless efficient artificial respiration is instituted. The breathing in spinal anesthesia is, on the whole, slow and rather shallow. Cyanosis is ominous, and necessitates immediate inquiry into the possibility of obstruction to the upper respiratory passages, to be followed by artificial respiratory measures if no improvement is obtainable in this direction.

The skin during spinal anesthesia, unless it extends high up, remains of normal color or becomes slightly pale. The sweating and suffusion of ether anesthesia are conspicuous by their absence. The urinary sphincter is probably not relaxed, no inconti-

nence of urine having, in my experience, been observed. The uterine contractions are weakened, but not abolished, by the procedure. The uterus contracts promptly after delivery. Hemorrhage during delivery or curetment for miscarriage is less than that occurring under chloroform or ether.

TECHNIQUE.—Solutions Used.—

The number of the spinal segments influenced in subarachnoid anesthesia depends not only upon the dosage and bulk of the injection, but also upon the specific gravity of the solution used, and the posture of the patient after the injection. Although the specific gravity of the cerebrospinal fluid is relatively constant, ranging almost invariably between 1.0055 and 1.0065, it is impracticable to use an anesthetic solution of approximately a like specific gravity with the expectation that it will remain indefinitely at the level of its introduction in the spinal canal. The slightest variations in the specific gravity of the cerebrospinal fluid causing the solution to rise or fall, it is desirable to use a solution either distinctly heavier or lighter than the cerebrospinal fluid. An increased specific gravity may be obtained by adding to the solution a little glucose, lactose, dextrin, or mannitol. Thus, Barker injects a 5 per cent. solution of stovaine in a 5 per cent. solution of glucose, the patient lying on the side, with shoulders and hips slightly elevated. After the injection the patient is cautiously rolled on the back, the elevation of the shoulders and hips being maintained with suitable pads or boards. The nerve-roots of the lower dorsal region are thus chiefly anesthetized.

Since it is often desirable to operate with the patient in the Trendelenburg posture or to lower the head where marked circulatory depression exists, I have been in the habit of employing, in most instances, a solution lighter than the cerebrospinal fluid, the patient being quickly laid on the operating table, with his shoulders about two inches lower than his hips, after the injection. Having experimented, as anesthetic drugs, with cocaine, alypin, eucaïne lactate, chloretone, stovaine, tropacocaine, and novocaine, I have been led to discard all but the last three, the following formulas being at present used:—

LIGHT SOLUTIONS.

- A. *Stovaine* 0.08 Gm. ($1\frac{1}{4}$ gr.).
Lactic acid 0.04 c.c. ($\frac{3}{4}$ min.).
Absolute alcohol... 0.2 c.c. ($3\frac{1}{2}$ min.).
Distilled water.... 1.8 c.c. (30 min.).
- B. *Tropacocaine* 0.1 Gm. ($1\frac{1}{2}$ gr.).
Absolute alcohol... 0.2 c.c. ($3\frac{1}{2}$ min.).
Distilled water.... 1.8 c.c. (30 min.).
- C. *Novocaine* 0.16 Gm. ($2\frac{1}{2}$ gr.).
Absolute alcohol... 0.2 c.c. ($3\frac{1}{2}$ min.).
Distilled water.... 1.8 c.c. (30 min.).

HEAVY SOLUTION.

- D. *Stovaine* 0.08 Gm. ($1\frac{1}{4}$ gr.).
Lactic acid..... 0.04 c.c. ($\frac{3}{4}$ min.).
Milk sugar (lactose) 0.1 Gm. ($1\frac{1}{2}$ gr.).
Distilled water, to make 2.0 c.c. (32 min.).

The addition of 10 per cent. of alcohol to the 4 per cent. stovaine solution reduces its specific gravity to about 0.992, causing it to ascend in the spinal canal, with the patient sitting up, at a rate approximating 10 centimeters (4 inches) a minute. The lactic acid is added to the stovaine solutions to retard its precipitation by the alkaline cerebrospinal fluid, stovaine having the alkaloidal property of being precipitated by alkalis.

The heavy solution is intended for cases in which it is desirable to elevate the head and shoulders of the patient during the operation.

Stovaine, the drug generally employed, is the most powerful anesthetic and motor paralyzant of the three, though likewise the most toxic, most actively hemolytic, and the strongest protoplasmic poison. **Tropacocaine** is somewhat less active as an anesthetic, while **novocaine**, though less toxic and non-hemolytic, is the least efficient of the three, and may not produce complete muscular relaxation even if analgesia exists.

Avoidance of toxic effects from this type of anesthesia necessitates careful preparation of the solutions to be used. These are best kept in sealed ampoules, each containing 2 c.c. (32 minims) of solution, and should be prepared under aseptic precautions and sterilized, not by boiling, but by intermittent exposure to a temperature not exceeding 65° C. (149° F.).

The dose, for the adult, of each of the solutions mentioned is 1 to $1\frac{1}{2}$ c.c. (16 to 24 minims), the larger amount being used only in the robust. Children withstand relatively large doses. Thus, 0.015 Gm. ($\frac{1}{4}$ grain) of stovaine, may be given in the newborn, 0.03 Gm. ($\frac{1}{2}$ grain) to a child of 5 years of average size and robustness, and 0.04 Gm. ($\frac{3}{4}$ grain) to a child of 10.

Site of Injection.—The action of the anesthetic drug in spinal anesthesia is tide-like, the influence gradually extending upward and, less noticeably, downward in the subarachnoid space from the point of injection. The highest nerve-roots in the range of diffusion of the drug having been reached, the tide of

analgesia gradually recedes toward the spinal segments close to the point of injection. The affected segments farthest from this point are thus subjected to the action of the drug in its most diluted form and for the least period of time. For prolonged and complete analgesia it is desirable, therefore, to inject the drug through an interspace adjacent to the nerve-roots corresponding to the field of operation. In operations on the perineum and anus, the injection is especially efficient if made through the third or fourth lumbar interspace, i.e., below the third or fourth vertebrae, respectively; in operations on the leg, through the second or third lumbar interspace; in those on the lower abdomen or groin, through the first lumbar interspace, and in those on the stomach, gall-bladder, or liver, through the twelfth dorsal interspace. A minimum dose injected through the last-named interspace, though it may suffice for upper abdominal work, may yield only a transient and patchy anesthesia for operations upon the legs or perineum.

High spinal anesthesia or analgesia involving the upper dorsal, the cervical, and the cranial segments may be produced by selecting a high interspace, especially the seventh cervical interspace as advocated by Jonnesco; by injecting a large quantity of a dilute anesthetic solution after withdrawing an equal quantity of cerebrospinal fluid, or by causing upward diffusion of an anesthetic solution having a specific gravity different from that of the cerebrospinal fluid. In some instances the withdrawn cerebrospinal fluid is used as the solvent for the anesthetic. As it is difficult to produce analgesia with-

out motor paralysis, shock, unconsciousness, respiratory and cardiac arrest, and especially blocking of the phrenics are not uncommon. To avoid these dangerous effects the dosage must be much reduced, so that a very brief, and at times imperfect, analgesia is produced. Jonnesco obtains an analgesia of about fifteen minutes' duration, and attempts, but imperfectly, to increase the safety of the injection by the addition of strychnine. While it is possible to do even craniotomies under high spinal anesthesia, the brevity of the effect, and especially the great dangers incurred, preclude its adoption as a justifiable method of anesthesia. Only when a drug is found capable of arresting sensory without motor conduction will high spinal anesthesia deserve consideration.

Syringe and Needle.—A glass syringe of the Luer type of 2 c.c. capacity, graduated with 0.1 c.c. divisions, is to be given preference. The piston of such a syringe, when properly made, fits loosely enough to be forced out by the pressure of the intradural fluid—an important feature in showing that the needle has entered the subarachnoid space.

To insure delicacy of manipulation, the needle should likewise be small and light. It should be of iridium-platinum or gold, to insure against breakage, and should be about 7 cm. long and 1 mm. in diameter. The point should be very sharp, but very oblique, so that the length of the bevelled portion shall be only about 2 mm. The needle should be provided with a well-fitting stylet, that its lumen may not become clogged during its introduction. It should fit the syringe accurately.

The syringe, needle, and stylet should be wrapped in gauze and boiled in water free from alkali for fifteen minutes just before using. (The addition of an alkali may decompose the anesthetic drug.) The apparatus should be brought to the operator while still very hot, not only to insure sterility, but also in order that the syringe may warm the anesthetic solution. The assistant opening the ampoule for the operator should previously have wiped the surface of the ampoule with a bit of gauze moistened with alcohol.

Preliminary Narcotization.—Retention of consciousness by the patient while in the operating room being often objectionable, it may in many instances be obviated by the preliminary injection of narcotics. In a robust adult $\frac{1}{6}$ grain (0.01 Gm.) of **morphine sulphate** and $\frac{1}{100}$ grain (0.0006 Gm.) of **scopolamine hydrobromide** are given hypodermically about seventy-five minutes before the time of operation. If in twenty minutes the patient answers questions without evidence of mental confusion, the injection is repeated, and in certain very resistant patients a third injection of morphine, either alone or combined with $\frac{1}{15}$ grain (0.004 Gm.) of **apomorphine hydrochloride**, if the delirifacient scopolamine action predominates, or of both morphine and scopolamine if the previous injections have produced little effect, is later given. In patients under 30 years of age, in whom the delirifacient scopolamine action often predominates, the initial injection may consist of $\frac{1}{4}$ grain (0.016 Gm.) of morphine and $\frac{1}{150}$ grain (0.0004 Gm.) of atropine. Such narcotization intensifies and prolongs the action of spinal anesthe-

sia. Properly applied, it enables the patient to pass through the operation oblivious of the fact that he has been removed from his bed. In shocked, debilitated, or aged patients it should, however, be employed with the greatest care, or avoided; likewise, in patients with marked respiratory depression, grave renal disease, or marked toxemia. Narcotics have been used in about 85 per cent. of our cases.

Consciousness may also be dulled by the administration of ether or other anesthetic by inhalation. Often a minute amount of **ether** will divert the mind or slightly obtund consciousness during the operation.

In children, narcotics are rarely required. After the spinal injection the child, if properly reassured as to the numbness and loss of power in the legs, will often fall asleep during the operation.

Associated Local Anesthesia.—Where the operator finds it necessary to extend his incision above the level of the analgesia, or the operation is so prolonged that the spinal effect in part passes off, a 1 per cent. solution of **novocaine** in saline solution may, with advantage, be used locally for the skin and subcutaneous tissues, and a 0.25 per cent. solution for the deeper tissues. In very extensive amputations it may be desirable to inject a 2 per cent. **novocaine** solution in the important nerve-trunks, not only to guard against imperfect arrest of conduction in the spinal nerve-roots, but also as an aid in prolonging the local analgesia.

Induction and Management of Spinal Anesthesia.—The patient's back, before he is brought to the operating room, is scrubbed with ace-

tone and painted with a 2.5 per cent. tincture of iodine; a dry, sterile binder is then applied. In the operating room the patient is sat across the middle of the operating table, the binder removed, and the back either flushed with alcohol or given a second coating of dilute iodine tincture. The assistant sees to it that the patient is sitting squarely across the table, that his hips are even, elbows parallel and at the sides, and the forearms crossed in front of the body. Facing the patient, he then stands on a low stool and holds the patient's hands with his own right hand, while his left arm encircles the back of the patient's neck and his fist makes pressure against the patient's abdomen. The patient's chin is thus forced down on his chest and the back arched without allowing him to lean forward.

The spinal interspace, through which it is desired to inject, is now located. This may be done by stretching a sterile towel between the iliac crests; its upper edge will cross the fourth lumbar spine or interspace. Or, the interspace opposite the angle formed by the last rib and the erector spinæ muscle may be noted; this is the first lumbar. From one of these known interspaces the desired space may be ascertained.

The injection should be made immediately before the operation, to avoid diffusion of the anesthetic and earlier loss of the effects. After drawing the contents of the sterile ampoule into the syringe, air-bubbles and any excess of the solution beyond the dose to be injected—usually 1.2 to 1.5 c.c. (20 to 25 minims)—expelled. The needle, detached from the syringe but containing the stylet,

should be inserted close to the mid-line, at about the vertical center of the interspace, at right angles to the body surface, and carried directly forward until it is grasped by the dense interspinous ligament. (In the dorsal region it is necessary to tilt the needle somewhat upward.) The grasp of the needle by the interspinous ligament—often cartilaginous in its consistency—usually indicates that it is being passed in the proper direction. If it encounters only loose tissue, it has probably deviated laterally, and should be withdrawn and reintroduced with more accurate orientation. The stylet is now withdrawn and the needle cautiously pushed forward with short, quick strokes, a few millimeters at a time. A cessation of resistance is noted as the needle-point leaves the interspinous ligament and enters the loose areolar tissue outside the dura, followed by slight resistance and a snap—sometimes audible—as the tense dura is punctured. Finally, the needle is partially rotated to insure complete penetration of the dura by its point. Cerebrospinal fluid should now drop fairly rapidly from the needle; if it does not, the needle may be cautiously rotated or slightly moved until the fluid flows freely. At times it is necessary to reintroduce the stylet, cautiously aspirate with the syringe, or seek another interspace, the latter being usually the best plan where there is much difficulty with the first attempt. At times, if the needle enters directly in the median line, a few drops of blood may flow from the venous plexus outside the dura; this apparently does no harm, and the blood is usually quickly followed by cerebrospinal fluid.

Only when the fluid is running freely should the charged syringe be adapted to the needle. The piston is first drawn out a short distance to permit cerebrospinal fluid to enter the syringe and mix with the anesthetic solution, as well as again to prove that the needle has been properly introduced. If a thorough diffusion is desired, a part of the mixture may now be injected, more cerebrospinal fluid drawn into the syringe, and this process repeated two or three times until the syringe is empty. Not over twenty seconds, however, should be consumed in giving the injection.

Finally, the needle is quickly withdrawn and, if a light solution has been used, the patient at once laid upon the table, slightly tilted with the head down, to be maintained in that position at least twenty minutes, or, if a heavy solution has been introduced, the head and shoulders kept elevated. Analgesia should develop in two or three minutes, and is determined by watching the face as the skin is pinched. If no analgesia is present after six minutes, the injection may be repeated, in the same dosage, and, perhaps, through another interspace.

During the operation the pulse and respiration should be continuously watched, the latter by observation of the to and fro movements of a wisp of cotton affixed to the end of the nose. Diverting conversation is often desirable in the minority of cases in which the patient is awake. Should the patient exhibit evidences of nausea, the head and shoulders must be lowered by further inclination of the table and a careful watch kept for respiratory depression or a fall of

blood-pressure. The latter, in the absence of respiratory arrest, need cause little alarm, but if the respirations become shallow or imperfect, a stimulating subcutaneous injection of 4 grains (0.26 Gm.) of **caffeine** and $\frac{1}{15}$ grain (0.004 Gm.) of **strychnine sulphate** should be given, and the surgeon stand ready to practise **artificial respiration** or an **intravenous injection of epinephrin**.

After-treatment.—Sealing or dressing of the point of lumbar puncture in spinal anesthesia is unnecessary, no signs of infection having developed in over 8000 anesthetics without the application of an occlusive dressing.

In patients who have received preliminary narcotic injections, an enema of 2 quarts of warm water, to which may be added 2 ounces (60 Gm.) of glucose and 3 drams (12 Gm.) of sodium bicarbonate, should be slowly run into the bowel immediately after the operation, and every four hours thereafter for the first twenty-four or forty-eight hours the patient should receive from 4 to 8 ounces (120 to 240 c.c.) of fluid by rectum. If the narcosis is too prolonged or intense, a pint (500 c.c.) of black coffee and 2 drams (8 Gm.) of tincture of capsicum may be given with the first enema. Constant watching, to detect early and remove any cause of obstruction in the upper air-passages, is required in such deeply narcotized subjects.

Spinal anesthesia does not contraindicate the administration of water or bits of ice, either during or after the operation. Such food as seems best in the particular case may be given without regard to the fact that the patient has been anesthetized.

INDICATIONS AND ADVANTAGES OF SPINAL ANESTHESIA.

Spinal anesthesia is applicable in patients of all ages, from the newborn to those in advanced life. It can often be used where ether is inadmissible, as in patients with acute pulmonary or chronic cardiovascular disease, or is known already to have produced dangerous symptoms.

Its chief value is in operations on the lower abdomen and pelvis. Probably no other form of anesthesia yields as great a degree of muscular relaxation in these regions with as little danger. Intra-abdominal manipulations are greatly facilitated by the relaxed parietes and contracted intestine it affords. A shorter incision may be made than under other anesthetics, and the anesthetic does not add to the patient's intoxication nor impede elimination. Particularly is the procedure valuable in acute peritoneal infections, as from the appendix. In such patients no preoperative preparation is necessary beyond the sterilization of the skin, and, possibly, the passage of a stomach-tube. The lowest mortality I have obtained in operating on the appendix—1.8 per cent. in a series of 220 consecutive and unselected cases, operated promptly upon admission to the hospital, and irrespective of the degree or duration of any associated peritonitis—was secured with spinal anesthesia.

Where meteorism exists or there is inflammatory ileus, evacuation of the intestinal tract usually takes place while the patient is on the operating table, and he returns to bed with a scaphoid abdomen. Three patients, apparently with mechanical intestinal obstruction of some days' duration,

resistant to many forms of treatment, were thus relieved by spinal anesthesia alone before an incision had been made.

With one exception, during the past twelve years, I have selected spinal anesthesia for all **abdominal operations** on the toxic, septic, or desperately sick, withholding operation only from those admitted to the hospital manifestly in a dying condition. It may be employed with unquestionable advantage in abdominal surgery in preference to ether where there exists an acute pulmonary or a severe cardiac, vascular, or renal disorder, particularly when associated with high blood-pressure.

Operations on the pelvic organs are very conveniently carried out under spinal anesthesia. A most satisfactory relaxation of the perineal muscles is afforded, and the relaxation of the anal sphincters—last to relax under ether, but among the first to relax under spinal anesthesia—facilitates operations on the lower bowel. In such cases an enema should not be used for some hours before the operation; the rectum must, however, have previously been thoroughly emptied, otherwise an evacuation will usually occur on the table.

In certain operations on the kidneys, spinal anesthesia seems especially valuable. Thus, I have not hesitated to operate on these organs simultaneously, nor to perform **nephrolithotomy** on a residual kidney after removal of the opposite organ. In one woman, aged about 60, for example, the residual kidney was opened three times for recurrent **calculi**. From **renal decapsulation** performed under spinal anesthesia for

advanced **nephritis**, with or without marked anasarca, I have observed no untoward effects. Spinal anesthesia seems also of especial value in **bladder resection** or removal for tumor, and in **prostatectomy**.

In **obstetrics** spinal anesthesia is of value to facilitate operative delivery. As W. A. Steel has observed, hemorrhage is markedly lessened in these cases, and there is an immediate soothing mental effect on the patient owing to the cessation of her suffering. The patient, holding to the side of the bed, with the arms over her head, is enabled herself to render aid in difficult forceps deliveries. The uterine contractions are not abolished, and the placenta may be expelled spontaneously. No ill effects are produced on the child. In private practice the method enables the surgeon to handle emergency obstetric operations without an anesthetist or trained assistant. The procedure may be employed in version or threatened uterine rupture. Uterine inertia is probably less frequent than after ether. In breech or version operations the after-coming head must be extracted rapidly, or else the lower uterine segment may contract on the neck (Steel).

In exsanguinated obstetric patients spinal anesthesia is frequently available where ether or chloroform would be contraindicated. In a case of **Cesarean section**, reported by J. C. Applegate, the uterus had ruptured sixteen hours before the operation and the fetus was in the abdominal cavity. Although the patient had to be brought about twenty miles to the hospital, and was pulseless and apparently moribund when admitted, she recovered upon operation under

spinal anesthesia, the heart action being maintained during the intervention by the intravenous use of epinephrinized salt solution. In a series of 14 cases of ruptured **ectopic pregnancy**, some of the "tragic" type, which I operated by the vaginal route under spinal anesthesia, there was no mortality. J. P. Marsh, of Troy, N. Y., has reported 4 successive and successful **Cesarean sections** for **eclampsia** under spinal anesthesia. It is especially desirable for operative delivery in this condition, owing to the relaxation and lowering of blood-pressure induced, without interference with elimination.

In **labor cases with heart disease** spinal anesthesia relieves the patient of all cardiac strain. H. R. M. Landis has found that child-bearing may be rendered relatively safe in tuberculous patients by instrumental delivery under spinal anesthesia.

The perineal anesthesia and muscle relaxation afforded by spinal anesthesia permit of immediate painless, thorough repair work on the birth canal (Steel).

Curettement for retained products of conception is performed with much less hemorrhage than when ether or chloroform is used. Reactionary hemorrhage seems to be less frequent. Hematomas and hemorrhagic extravasations in wounds are uncommon, in spite of the fact that fewer vessels require ligation in operations under spinal anesthesia than under ether.

Spinal anesthesia prevents, to a remarkable degree, the production of **shock** by operative measures carried out under its influence (though it accentuates pre-existing shock). Its great rapidity of action—surgical analgesia being almost invariably in-

duced within two minutes, and usually in a still shorter time—is often a marked advantage.

Secondary nausea or vomiting should not occur as a result of spinal anesthesia, and the patient should have less postoperative pain, less headache, less backache, and less general discomfort than if he had received ether (J. O. Bower). The suffusion of the skin, drenching sweats, and heat radiation of ether are absent. Albuminuria does not occur.

The repeated production of spinal anesthesia in the same person seems no more harmful than a single injection. One patient was subjected to it no less than eleven times for repeated plastic operations for hypospadias, without evidence of spinal cord or root injury.

CONTRAINDICATIONS. —

Whereas in aneurism, threatened decompensation in valvular heart disease, in the excessive vascular tension of eclampsia, in nephritis, and in advanced arteriosclerosis the vasorelaxation induced by spinal anesthesia may be of protective value, the procedure should be used with care and diminished dosage, or avoided, in conditions of marked hypotension, *e.g.*, in severe shock and where great depression or exhaustion of the spinal centers exists. Patients nearly or quite pulseless from traumatic shock should not, as a rule, be subjected to spinal anesthesia until reaction has occurred. The low blood-pressure induced favors cardiac arrest in certain forms of myocardial disease, as well as in thoracotomy and other operations causing sudden changes in intrathoracic tension.

Patients with advanced peritonitis,

marked abdominal distention, and cyanotic extremities, especially when of the middle aged, obese type; patients in collapse from traumatic ileus; patients with advanced septic disease of the biliary system and associated marked myocardial weakness, and patients greatly depressed and toxemic, or with mechanical limitation of respiratory space, as from large serous or purulent effusions or massive intrathoracic growths, are not good subjects for spinal anesthesia. In patients in collapse from hemorrhage or with large fibroid tumors and myocardial degeneration the intradural injection should be given with great caution.

Obese patients with a short, thick chest and limited breathing apparatus are less suited for the method than subjects with ample breathing space. Aged and debilitated patients should receive relatively small doses of the anesthetic drug.

Greatly depressed subjects, who may be carried through an operation with local anesthesia or a few whiffs of ether, should not be given the spinal injection.

Should spinal anesthesia be administered to a person with marked circulatory hypotension, direct preparations for intravenous introduction of epinephrinized saline solution should be made before the operation, as described in the following section.

Spinal anesthesia should not be employed by those who have not developed a trustworthy aseptic technique or have not carefully mastered the physiology of the method, including an understanding of the dosage and mode of diffusion of the drug. Neither should the procedure be used if the patient cannot be properly

watched for one hour after the injection, or if the operator is unprepared to meet emergencies.

TECHNICAL DIFFICULTIES, COMPLICATIONS, AND SEQUELÆ.—Position of the Patient.

—In rare instances a patient is unable to breathe when recumbent. For such a subject a solution of high specific gravity should alone be used, or, better, local anesthesia substituted. In the ordinary case, in which the light solution is being used, the patient should not be raised to a sitting posture for one-half hour after the injection, lest syncope be induced. Carrying the patient about after the injection is dangerous; without constant watchfulness the orderly or resident will lift or carry the patient with the head and shoulders raised, thus exposing the higher spinal segments to the action of the anesthetic.

Breaking the Needle.—This mishap occurred in my experience upon using a very delicate, highly tempered steel needle in a young child, the needle breaking when the child suddenly straightened the back; removal of the fragment was soon successfully effected. I know of no instance in which a *platinum* needle has broken beneath the skin.

Lack of Anesthesia.—This may result not only from the use of an imperfect solution, but from failure to introduce the needle properly, or from leakage of the solution outside the arachnoid. In one kyphotic dwarf I failed to enter the spinal canal. In two other patients the bony canal was entered, but no cerebrospinal fluid could be obtained and no very obvious analgesia followed. In still another case, fluid was obtained, but despite repeated injec-

tions no anesthesia resulted, probably because the fluid was extradural. In rare instances the injection must be repeated or another anesthetic used.

Dosage.—The chief drugs used in spinal anesthesia are still under proprietary control and may not have been rigidly standardized, different samples of a given drug apparently showing variations in activity amounting to as much as 30 per cent. At times we have found 0.04 Gm. ($\frac{2}{3}$ grain) of stovaine a proper dose, and again 0.06 Gm. (1 grain). As a 10 per cent. increase in the dose may be dangerous, these variations in activity necessitate great care in the employment of every new lot of the anesthetic.

Circulatory Depression.—In patients nearly pulseless, before the spinal injection, a needle connected with a funnel containing physiological salt solution should be tied into a convenient vein before the operation is begun. The salt solution may then be run into the vein from time to time as indicated, from 1 to 10 drops of 1:1000 epinephrin solution being added to each 6-ounce (180 Gm.) funnellful if the patient becomes actually pulseless at the wrist. The introduction of epinephrin should be cut off by pinching the tubing as soon as the pulse returns, for fear of an excessive action upon the heart. For weak patients, not sufficiently asthenic to require the procedure just referred to, the subcutaneous injection of 1 ampoule of pituitrin of 3 to 5 minims (0.18 to 0.3 c.c.) of epinephrin at the beginning of the operation may be of value. For nervous faintness, inhalation of aromatic spirit of ammonia, or a few drops of ether may be tried.

Respiratory Depression.—To a very weak subject, 4 grains (0.26 Gm.) of **caffeine** and $\frac{1}{15}$ grain (0.004 Gm.) of **strychnine sulphate** should be administered subcutaneously to anticipate respiratory depression. The same injection should be given in other cases in which the respiration is observed to weaken. If the breathing ceases, **artificial respiration** should be practised, most conveniently, as a rule, by rhythmic compression of the thorax, the surgeon clasping his fingers down over the patient's sternum and making pressure downward and inward sixteen to twenty times a minute, a procedure which may be aided by the hands of the assistant, placed under and below the elbows of the surgeon. The patient's arms are, meanwhile, extended above the head. Oscillations of the cotton wisp on the patient's nose prove the efficacy of the artificial respiration, which should be continued, if necessary, for one hour or more, or until the patient can again breathe spontaneously.

Where obesity or an abnormal intrathoracic state interferes with the thoracic compression procedure, forced artificial respiration should be tried, either with the **pulmotor** or **lungmotor**, if quickly available, or in a sudden emergency, by the insertion of a full-sized **tracheal tube** and direct **rhythmic inflation of the lungs** by the surgeon or assistant through a piece of drainage-tube cut off square and held intermittently against the external plate of the tracheal tube.

Upon continuing artificial respiration until depression of the respiratory centers has passed off, the patient, perhaps pulseless, relaxed, and pale, awakens as though miraculously resurrected.

Early After-effects.—*Nausea and Vomiting.*—In a large series of our spinal anesthesia cases, 18 per cent. had slight nausea and 13 per cent. vomited during the operation. This is probably due to involvement of the upper dorsal nerve-roots by the anesthetic, with the resulting cerebral anemia. The condition soon passes off.

Slight nausea and vomiting were shown by 24 per cent. of the cases after being returned to their beds. This was either associated with an intra-abdominal condition that would produce nausea or was secondary to the use of morphine or other narcotic drug. On the whole, our impression is that spinal anesthesia does not produce any postoperative vomiting unless meningeal irritation occurs. The showing in this respect is far more favorable than that of our ether cases.

Headache.—Mild headache followed in 21 per cent. of our spinal anesthetics. Fifty per cent. of the ether patients had headache, which was, as a rule, more severe than after the spinal procedure. We have recently seen no severe headaches after the latter. Headache of the characteristic spinal type, i.e., increased by raising the head from the pillow and associated with some stiffness of the neck muscles, indicates the use of a contaminated or deteriorated solution, which should be promptly discarded.

Backache.—Sixteen per cent. of our spinal anesthesia cases complained of this symptom, as against 61 per cent. of the ether cases.

Postoperative Pain.—The average duration of incisural pain after spinal anesthesia was twenty-nine hours, as against forty-eight hours after ether.

Albuminuria.—Despite a number of uranalyses, we have found no evidence that the intradural injection irritates the kidneys. This is corroborated by the tolerance of patients to repeated or extensive operations on the kidneys, in spite of existing serious renal disorders.

Remote After-effects.—*Injury to Nervous Tissues.*—Puncture of the spinal cord by the needle produces no symptoms, and, while it is to be avoided, is relatively harmless. Lateral deviation of the needle with injury to a nerve-root may, however, be followed by a severe neuritis and secondary palsy, which is rarely permanent. Touching a nerve-root with the needle-point produces a lightning-like pain usually radiating down the leg. If this occurs the needle should be immediately withdrawn and reintroduced.

Secondary degeneration of the spinal cord from the chemical action of stovaine, as used in spinal anesthesia, does not, in my opinion, in the least degree occur. Experiments on dogs in this connection are entirely misleading, owing to anatomical differences and the differences in the action of dilute and concentrated solutions of stovaine.

Palsy of the abducens nerve, though met with several times in our earlier spinal anesthetics, has not occurred in a series of over 4000 recent injections. The condition is peculiar in developing in from seven to twelve days after the injection. Usually a single abducens is involved, but at times the palsy is bilateral. Recovery usually follows in from a few days to several months. Our cases occurred in a period during which the anesthetic was often producing

headache and pain in the back of the neck. The period of incubation and the associated meningeal irritation suggest that the condition is due to the use of a solution contaminated with bacteria.

Neurotic Symptoms.—Weakness of the legs, backache, headache, and various pains are frequent after abdominal and especially after pelvic operations, whether ether or spinal anesthesia has been used. In the neurotic, especially those with pelvic symptoms, spinal anesthesia should accordingly be employed with caution. Such patients, particularly if influenced by prejudiced persons, will often attribute all symptoms such as the above to the intradural injection.

Mortality.—The safety of any anesthetic depends, to a considerable extent, upon the experience and skill of the user. In comparing the mortality from spinal with that from ether anesthesia, one should be mindful of the fact that the relatively favorable ether statistics frequently quoted do not actually represent conditions as they obtain in the general use of the drug, including its employment by the inexperienced and imperfectly trained, in sudden emergencies, under unpropitious circumstances, and upon patients poorly prepared for the anesthesia. Our own experience with ether as administered by internes in hospitals, and the results of inquiry into the experience, personal or otherwise, of several of my associates and assistants, suggests a mortality of about 1 in 500 in ether anesthesia.

As for spinal anesthesia, from upward of 5000 injections, including many administered by my assistants and associates, we have had 10 deaths

on the operating table, and 1 death after operation, in which the anesthesia was a factor. Three of these died during or after operations for large empyemas—a condition now recognized as contraindicating spinal anesthesia. Two patients died under operations for gall-bladder disease associated with peritonitis; one of these apparently was drowned by profuse, regurgitant vomiting as the operation was being completed, while the other was obese and had a serious valvular lesion. Of the remaining 5 cases of early death three were nearly or quite pulseless before the anesthesia had been induced, the fourth was an infant with advanced general miliary tuberculosis, succumbing during the search for an intrapulmonary abscess, and the fifth was an obese, elderly man with extensive intestinal gangrene and diffuse peritonitis. These 5, properly to be considered as inoperable, were in a hopeless condition under any form of treatment. The eleventh case, that of an obese colored woman with a fibroid tumor, who died from circulatory depression about two days after the operation, was the only fatal case in which the patient had been in even a fair condition at the time of anesthesia.

In 4 of our spinal anesthesia cases attempts at etherization had been made in other clinics. In each case the operation had to be abandoned, as the patient collapsed, and it was evident that complete etherization would be fatal. In each of these patients, without special preoperative treatment, the operation was successfully performed under spinal anesthesia, with subsequent recovery. Similar results were obtained in sev-

eral additional cases in which operation had been refused at other clinics on account of advanced sepsis, old age, or other cause.

On the whole, in our experience ether and spinal anesthetics have proven about equally dangerous, the former from exigencies necessitating a profound narcosis or the participation of an imperfectly trained anesthetist, the latter from faulty selection of patients and, for a time, imperfect knowledge of the action of the anesthetic drug. These factors favoring a high mortality in spinal anesthesia having been eliminated, we have had no mortality from it during the past three years. Even if skillfully administered, spinal anesthesia is probably more dangerous than a transient and light narcosis under ether or nitrous oxide-oxygen; but it is safer than is a prolonged narcosis with complete muscular relaxation under ether or nitrous oxide-oxygen. Spinal anesthesia produces the greatest degree of muscular relaxation with the least protoplasmic disturbance. The method has been repeatedly selected by my medical associates, assistants and nurses for operations on themselves or members of their families.

Although relatively safe and very effective when used skillfully, spinal anesthesia is undoubtedly a dangerous as well as unreliable procedure in the hands of those who do not understand its action. Ability properly to select patients suitable for its employment is of paramount importance. For general, indiscriminate use ether remains the standard anesthetic despite its many drawbacks. The novice should not attempt spinal anesthesia without careful investigation of

the subject, and should apply it only in robust cases until due dexterity and familiarity with the technique have been acquired.

SACRAL ANESTHESIA.—In this type of anesthesia, also termed *epidural anesthesia* by Cathelin, its originator, and *extradural anesthesia* by L  wen who, in 1910, first reported material success with it, an anesthetic solution is injected through the sacral hiatus into the pocket formed in the sacral canal below the level of the second sacral segment owing to the closure of the spinal dura mater around the nerve-trunks forming the cauda equina. The method has also been termed *caudal anesthesia*. The sacral pocket referred to is completely isolated by the dura from the subarachnoid space above; none of the anesthetic solution, therefore, mixes with the cerebrospinal fluid. The areas affected in this procedure are merely those from which sensory nerve-fibers pass to the centers through the sacral plexus. In the sciatic distribution collateral innervation maintains sensibility; the fully anesthetized region, therefore, includes only the perineum, the anus and lower rectum, the urethra and penis, the lower part of the prostate, the scrotum, but not its contents, and, in the female, the external genitals and vagina (P. Bull).

Novocaine is the anesthetic drug generally used. Bull (1915) generally injects 20 c.c. (5 drams) of a 2 per cent. solution, plus **epinephrin**. Lewis and Bartels (1916) use from 40 to 90 c.c. ($1\frac{1}{3}$ to 3 ounces) of a mixture in equal parts of 1 per cent. novocaine solution and 1 per cent. **potassium sulphate** solution, made with freshly distilled sterile water,

with 2 drops of 1:1000 **epinephrin** solution added for each 30 c.c. (1 ounce) of the combined solution.

During the injection the patient is placed on his right side, with head slightly elevated and back strongly curved. After proper local cleansing the sacral hiatus is located, just below the spinous process of the sacrum and above the coccyx, in the midline. Lewis and Bartels infiltrate the skin and deeper soft tissues over the hiatus with the anesthetic solution before making the injection. The needle is first held at 45° with the skin surface, but as soon as penetration of the ligamentous membrane covering the sacral hiatus is felt, the syringe is carried down almost to a level with the body plane at that point, and the needle made to follow the axis of the sacral canal, into which it is introduced for a distance of $1\frac{1}{2}$ or 2 inches. If, in error, the needle has gone up too far and passed through the dura into cerebrospinal fluid, numerous drops of the latter will escape through the needle when the trocar wire is withdrawn.

Care should always be taken, before administering the injection, to ascertain that the needle has not entered a vein. The injection should be given slowly.

The method differs radically from spinal anesthesia in the time required for development of the analgesic effect, from eight to twenty minutes being consumed in the permeation of the anesthetic through the dura covering the nerve-trunks. The anesthesia lasts for about an hour (Siebert). Relaxation of the sphincters and pelvic floor is a salient feature of the method.

Lewis and Bartels report 13 pros-

tatectomies, 68 cystoscopies, 2 cystotomies, and 1 external perineal urethrotomy performed under caudal anesthesia. In the cases of suprapubic incision local infiltration anesthesia at the site of incision was also used. Three of the prostatectomies required partial or complete ether anesthesia in addition. Among the 68 cystoscopies there were 13 instances of only partial analgesia and 5 of no analgesia (3 of these failures due probably to faulty technique). Bull reports imperfect anesthesia in 15.6 per cent. out of 60 cases.

Complications are uncommon and not dangerous. The method is deemed especially advantageous by Lewis and Bartels in aged bladder and prostatic cases already so reduced by pain, back pressure, and toxemia as to possess no resisting powers to stand further depletion by other methods of anesthesia. Stoeckel (1909) applied the procedure in 141 cases of **childbirth**, with distinct relief from pain in 111 cases. A tendency to arrest of uterine contractions when the injection was made at the beginning of labor was noted; but when once the contractions had well started, there was no such effect. Successful results were also obtained with sacral anesthesia in 5 cases of **dysmenorrhea**.

As long ago as 1901 Cathelin used injections of normal saline solution into the sacral canal for **enuresis**, **tabetic crises**, etc.

Sacral anesthesia is, with difficulty, applied in the obese, the very nervous or hysterical, and in children. According to Suchy, it is contraindicated in the alcoholic.

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SPINAL CORD, DISEASES OF.—GENERAL CONSIDERATIONS.

The diseases of the spinal cord, including the various congenital and acquired deformities and anomalies of development, together with the primary or complicating affections of the meninges, are more than fifty in number. Of this list, infantile spinal paralysis, myelitis, and locomotor ataxia constitute collectively probably three-fifths of all the cases. Locomotor ataxia has been described in a separate article; so have multiple sclerosis and the forms of meningitis. Abscess of the cord is best studied in connection with caries of the vertebra, with which it is often associated. The non-traumatic vascular diseases of the cord—hemorrhage, embolus, thrombus, and aneurism—are exceedingly rare, and this is true also of tumors, though perhaps less so. The spinal type of progressive muscular atrophy has been included among the diseases of the muscles.

INFANTILE PARALYSIS; POLIOENCEPHALOMYELITIS.

SYNONYMS.—Infantile spinal paralysis; myelitis of the anterior horns; acute atrophic paralysis; essential paralysis of children; West's morning paralysis.

DEFINITION.—An infectious disease due to a minute micro-organism, characterized by a purely motor paralysis of flaccid type, occurring usually in young children, the paralysis being followed by rapidly developing atrophy, with degenerative electrical reactions in the affected muscles.

Not all children and relatively few adults are susceptible to infantile pa-

ralysis. Young children are more susceptible, generally speaking, than older ones; but no age can be said to be absolutely insusceptible. When several children exist in a family or in a group, one or more may be affected, while the others escape or seem to escape. The closer the family or other groups are studied by physicians, the more numerous it now appears are the number of cases among them. This means that the term "infantile paralysis" is a misnomer, since the disease arises without causing any paralysis whatever, or such slight and fleeting paralysis as to be difficult of detection. Simon Flexner (Public Address, New York, July 13, 1916).

An *acute*, a *subacute*, and a *chronic* form are recognized, the last commonly observed in adults.

Formerly our conception of the disease was that of a pure, flaccid motor paralysis without cranial-nerve involvement or cerebral implication, the lesion being constant and limited to the giant cell of the anterior horns. Epidemics of poliomyelitis had been noticed, though infrequently, and a growing belief existed in the theory of some specific micro-organism.

Between 1902 and 1908 a number of epidemic outbreaks occurred in various sections of this and other countries, and such variations from standard appeared in the clinical picture as to modify completely its interpretation. Adults as well as children were attacked, many cases proved fatal, cranial nerves were frequently affected, sensory disturbances, though temporary, were, at times, conspicuous, and the gravest cerebral complications were noted. The picture, in short, was that of involvement of the entire motor neuron system, cortex, basal and cord. This complex picture continued to be the rule up to within the past two or three years, since which time I have noticed a reversion to the old classic type. The final demonstration by Flexner and Noguchi of an almost ultra-microscopic organism, capable of inducing the disease in monkeys and recoverable from its victims, establishes its etiology as one of specific infection.

SYMPTOMS.—Prodromata are rare, as a rule. Irritability, malaise, weakness, nausea, constipation or diarrhea, coryza, bronchitis, tonsillitis or restlessness may precede an attack. These may disappear completely and be followed a few days later by poliomyelitis. Bronchopneumonia may then develop owing to paralysis, or, at least, paresis of the respiratory muscles.

The disease begins abruptly, usually with some fever. The temperature may be only slightly elevated (1 to 3 degrees), the range being higher and the fever more prolonged, the older the child. In the New York epidemic of 1907 the temperature ranged from 101° F. to 104° F. (38.3° C. to 40° C.), but higher temperatures, 105° F. to 106° F. (40.5° C. to 41.1° C.), have, though rarely, been noted. A definite chill is also rare. There may be slight digestive disorders, such as vomiting and diarrhea, slight headache, and sometimes pain in the back and the limbs. These general symptoms vary in intensity with the temperature. In about one-fourth of all cases the onset of the disease may be marked by a convulsive seizure. The younger the patient and the higher the temperature, the more likelihood is there of convulsions, which, however, are rarely repeated more than once or twice. Some cases, however, run their course without fever.

Headache is common, at least in patients old enough to complain. In the New York epidemic it was usually general or frontal, but in cases observed by Wickman, it was occipital. It is moderately severe, as a rule, but is occasionally intense. Prostration is marked when the on-

set is sudden, as also in many mild abortive cases. Albuminuria and anuria are occasional; incontinence rare. The bladder and rectum are not involved.

Besides the irritability observed, early excitement, restlessness, anxiety, and mental perturbation are commonly noted. This is followed, particularly in children, by a period of apathy or drowsiness, with some confusion on waking. This confused state may lapse into mild delirium of short duration. Convulsions sometimes occur also in children as noted above. On the whole, however, the patient tends to retain consciousness throughout the illness, even in lethal cases, and coma is rare. Pain is complained of early, particularly in the back of the neck and spine. The pain in the face, arms, and legs resembles that of myalgia, but it may present the characteristics of neuritis, with hyperesthesia and tenderness over the nerve-trunks. This may persist for weeks, but, as a rule, the pains subside with or before the onset of paralysis. Again, meningeal symptoms—stiffness of the neck and spine, contraction of the spinal muscles with retraction of the head—may be noted in addition to the pain in the same areas. Kernig's sign—inability to extend the leg when the thigh is flexed at right angle—is also present in some cases.

Both in cases which do not result in paralysis and those that do, muscular twitchings, jerks and tremors usually occur. They may first be elicited when the physical examination is made, or during sleep, when they are most noticeable. At first the patellar reflex is exaggerated, but it is invariably diminished or abolished

before the onset of paralysis. It may, however, be abolished on one side and exaggerated on the other.

After a few days—usually 2 or 3, rarely more than 10—the fever and general disturbance subside, and not until then, usually, is the true nature of the illness made evident by the discovery of a flaccid motor paralysis, which may at first affect all of the extremities as well as the trunk-muscles. If suspected and sought for, however, the paralysis may often be detected during the febrile stage. Within a week or two the general paralysis clears away, leaving a residual paralysis limited to one or more limbs, or, it may be, to a single muscle or group of muscles. Such groups are invariably of muscles of associated function. The lower limbs are rather more frequently affected than the arms. A paraplegic distribution is common, a hemiplegic distribution exceedingly rare.

In perhaps one-fourth of all cases among children the onset is even more abrupt than as described. The child may be put to bed in apparent good health, sleep quietly or perhaps a little restlessly through the night, and is found the following morning bright, cheerful, and with a hearty appetite, but paralyzed in one limb, or, it may be, with a paraplegia, the affected limb hanging helpless and inert. Such cases were described in the older literature as *West's morning paralysis*.

Within 2 weeks usually, sometimes much earlier, the muscles paralyzed begin to atrophy. The wasting sometimes progresses rapidly. If the child is fat, this atrophy may not be apparent to the eye, but palpation will at once make it evident. Not only

does the limb look wasted, but it usually presents a bluish, cyanosed appearance, and to the touch of the examiner it is distinctly colder than its fellow. The deep reflexes are lost, if affected at all.

Simultaneously with the atrophy, or it may be a little later, an alteration both quantitative and qualitative may be noted in the response to both the faradic and galvanic currents. To the faradic current the muscular response is at first simply diminished. It grows more and more feeble from day to day, and is eventually lost completely in severe cases. To the galvanic current the nerves involved show at first beginning and later more or less complete reaction of degeneration. In making these electrical tests the corresponding sound muscles in the unaffected limb should be used for comparison. Minor changes can only be determined in this way.

Within a few months various deformities from contraction and unopposed muscular antagonism may develop. Talipes varus and equinus, and many other deformities are possible. Sometimes an arrest of development occurs, one limb after a few years being shorter than the other, or one hand or foot smaller than the other.

Chronic poliomyelitis is one of the forms of progressive muscular atrophy and, together with the subacute variety, differs chiefly in the mode of onset and rate of progress, but not the nature of the paralysis.

Individual cases so vary from the classic type in recent years as to suggest the presence of different affections. Wickman, of Stockholm, Sweden, after a careful study of the

Scandinavian epidemic, and a clinical study of 1025 cases, showed, however, that all the supposed disorders were but different forms of the same disease. An analysis of Wickman's paper, by Dr. W. R. Ramsey, of St. Paul (*Jour. Minnesota State Med. Assoc.*, Dec., 1909), so ably summarizes this important contribution that it is reproduced below as accurately descriptive of the disease as we have been seeing it in the past ten or fifteen years.

Poliomyelitic Form.—The sickness almost always begins acutely with fever and general indisposition. The expressed opinion of several authors, that in a great percentage of the cases the paralysis appears without preceding initial symptoms, is certainly incorrect and rests upon insufficient observation. Sometimes the acute symptoms are preceded by indefinite prodromata. Sometimes the disease develops in two phases with a distinct pause between, so that the patient, partially or even completely, recovers from the initial symptoms and then again becomes ill with accompanying paralysis.

Among the initial symptoms are pain and a somewhat characteristic hyperesthesia. Another series of initial symptoms are meningitic irritation, pain in the back of the neck, and sometimes complete opisthotonos. In many cases the gastrointestinal symptoms, vomiting and diarrhea, are so severe that the disease assumes the stamp of an acute gastrointestinal catarrh. During the first days it is not seldom that retention of urine is observed, but this disappears, without exception, in a short time. The severity of the onset and of the initial symptoms cannot be depended upon to determine the future course of the disease.

The generally accepted opinion that the paralysis continues for life and that it is always attended by atrophy and the reaction of degeneration, is not true; on the contrary, there are many cases which only show a transient paralysis of several days to several weeks when the paralysis completely disappears.

The paralysis may involve the different muscle groups and may sometimes limit itself to a definite muscle group, *e.g.*, the muscles of the neck. Sometimes most unusual symptoms appear, *e.g.*, the pupillary symptoms and optic neuritis.

Sensibility to pressure over the nerves and muscles appears in a considerable number of cases. In rare cases there is a marked interference with sensibility, or partly a dissociated paralysis of sensation, or sometimes a complete anesthesia as a result of the changes in the anterior horns of the cord. Pretty constantly appears a diminution in the so-called electric sensibility, and, indeed, in many cases one can speak of a partial paralysis of sensibility or sensation.

Concerning the tendon reflexes: The patellar reflex comes chiefly under consideration. These are by no means always absent. An exaggeration of these reflexes may precede their complete disappearance. Incomplete paralysis of the leg with increase of the patellar reflex may remain. In affections of the upper part of the cord the patellar reflex may be increased as an indication that the white substance is also involved.

Landry's Form.—In another series of cases the disease takes on an extensive course, and, indeed, the different muscle groups may become involved, either in an ascending or descending manner.

In case the muscles of respiration are involved, which means an affection of the respiratory center, the disease assumes the form of Landry's paralysis. Since the progress of the paralysis may be more easily followed in adults than in children, the erroneous reports, which are found generally in the literature, explain the different ages, as also the prognosis of poliomyelitis. Landry's paralysis in a child is generally diagnosed as poliomyelitis, while a fatal poliomyelitis in an adult is generally diagnosed as Landry's paralysis.

Bulbar Form.—The bulbar and brain forms may occur together or separately. Most often in these forms facial paralysis appears, but frequently also an affection of the hypoglossus and eye muscles may occur. Sometimes the disease takes the form of an acute bulbar paralysis, but this

form appears to be rare. Sometimes there exists an injury to the center of accommodation, and thereby an ataxia of the cerebellar type or an exaggerated condition of the reflexes may occur.

Encephalitic Form.—Under this form are considered all cases of cerebral paralysis.

Ataxic Form.—This form appears as a transient, acute ataxia, which most frequently resembles the cerebellar type.

Polyneuritic Form.—When I mention this as a separate form I do so from purely practical grounds. During the epidemic many cases appeared which, when grouped, were that of a distinct polyneuritis. To this form belong, first, cases which in a comparatively short time completely recover, especially when they are accompanied by well-pronounced disturbance of sensation, such as pain and paresthesia; second, cases which present such local symptoms as pain upon pressure on the nerves and muscles, and which may be regarded as an affection of the peripheral nerves; third, those cases under form 5 mentioned as the ataxic form. The last two forms, 5 and 6, correspond to what is described in the literature as acute motor infectious neuritis. Clinically they cannot be differentiated from this form, but etiologically they are not identical. The pathological investigations have not been able to differentiate these forms, but since so many cases occurred during this epidemic of poliomyelitis, we must assume them to be of common origin and that the disease is really a transient poliomyelitis. That the differential diagnosis between acute poliomyelitis and polyneuritis under other conditions must first be considered, is self-evident.

Meningitic Form.—As before mentioned, in the initial stage and, indeed, not seldom meningitic irritation appears. This may be so severe and characteristic that one thinks he has to do with an acute meningitis. Later, however, the appearance of the paralysis usually makes the condition clear. The usual paralysis may, however, remain absent, so that the whole course is that of a meningitis serosa. This was demonstrated during the epidemic, clinically as well as by autopsy.

It is then natural to conclude that at

least a part of the sporadic cases of serious meningitis results from the poison of the acute poliomyelitis.

The opinion of several investigators, that there exists a relation between the etiology of epidemic cerebrospinal meningitis and infantile paralysis, is, in my opinion, not sound. The difference in the whole course of the diseases, in the individual symptoms, as well as in the anatomical changes, is so great that we are justified in regarding them as two distinct diseases.

Abortive Form.—Frequently other cases occurred in the vicinity of the typical cases of poliomyelitis, which, in general, gave only the picture of a general infection, but of which the symptoms correspond to the initial symptoms of the typical ones. Such cases must be termed abortive forms. One can, however, differentiate various types of the abortive form:—

(a) Cases which run the course of a general infection.

(b) Cases in which there is some meningeal irritation.

(c) Cases in which the painful symptoms are well pronounced (influenza type).

(d) Cases in which the gastrointestinal symptoms are especially marked.

How far anatomical changes of even the slightest degree are present in these abortive cases is not, with any certainty, decided.

DIAGNOSIS.—An early diagnosis, *i.e.*, before the onset of paralysis, would prove of service as regards prophylactic measures, were any such available.

We must accustom ourselves to keep the possibilities of poliomyelitis more frequently in view. Any case of acute febrile disease, especially in children, which is characterized by a general hyperesthesia of the skin with a tendency to profuse sweating, absence of leucocytosis, weakness, and decrease of the muscle tonus in certain muscle groups with diminished tendon reflexes should strongly arouse suspicion. Sparck (*Med. Klinik*, Dec. 22, 1912).

The prodromal symptoms enumerated under the foregoing heading are important in this connection: Irritability and restlessness several days before other symptoms appear; headache, vomiting, then slight spinal rigidity with occipital headache and backache, particularly along the spine when any attempt at rotation of the trunk is made; marked and persistent asthenia; rapid and weak pulse; hyperesthesia; pains in the limbs with exaggerated patellar reflex—are suggestive in the absence of an epidemic, and especially so when one prevails.

In some forms of poliomyelitis, the brain, medulla, and pons are specially involved, leaving the cord, for the most part, unaffected permanently,—really cases of polioencephalitis. Some of these cases closely resemble cerebrospinal meningitis. The differential points are: (1) In poliomyelitis there is a short preliminary period in which patient, having had high fever, continues to be about; not in meningitis. (2) Increasing sopor, extending over days, in poliomyelitis; this is quite unlike the onset of cerebrospinal meningitis. Other cases closely simulate tuberculous meningitis. Differential points: (1) In polioencephalitis, onset is sudden; in tuberculous meningitis, gradual. (2) In former affections, there occurs a gradual diminution of the preliminary sopor, and in a week or two patient is brighter; in tuberculous meningitis sopor deepens into coma. Koplik (*Amer. Jour. Med. Sci.*, June, 1911).

Hitherto unobserved preparalytic symptom consisting of a peculiar twitching, tremulous or convulsive movement of certain groups of muscles, lasting from a very few seconds to somewhat less than a minute. The amplitude of vibration is greater than in a tremor, not so constant. Colliver (*Cal. State Jour. Med.*, Nov., 1913).

Congestion of the throat is almost constant during the early acute stage. It is usually limited to the faucial mucosa and the pharynx, while the soft palate assumes a deep red color and often, in addition, a distinct violaceous tinge. The latter, when pronounced, is somewhat distinctive. Regan (Arch. of Pediat., Dec., 1917).

Tuberculous meningitis may be simulated. The spinal fluid in this case may contain tubercle bacilli, and injection of it into a guinea-pig may facilitate differentiation. There may be an evident primary focus, and also choroidal tubercles. Syphilitic meningitis is determined by a positive Wassermann. Other diseases to be excluded are gastro-intestinal disturbances, rickets, scurvy, acute arthritis, and tuberculosis of the hip. Tumpowsky (Ill. Med. Jour., Apr., 1918).

Report of experiments indicating that the virus is regularly present in the nasopharynx in the first days of illness and decreases relatively quickly as the disease progresses, except in rare instances; and that it is unusual for a carrier state to be developed. Flexner and Amoss (Jour. of Exper. Med., Apr., 1919).

In several personal cases and others observed by colleagues in a recent outbreak, all had at the outset a catarrhal inflammation of the nose and throat and but few gastro-intestinal signs. Abrahamson (N. Y. Med. Jour., April 20, 1921).

A lumbar puncture made at this time may confirm the diagnosis by demonstrating a slight opalescence or milkiness in the spinal fluid withdrawn, which opalescence indicates the early appearance of paralytic phenomena. It also contains, after a preliminary fall, an excess of leucocytes, mainly lymphocytes, tending to reach the maximum when paralysis impends.

The value of lumbar puncture as an aid in diagnosis between cases of acute cerebrospinal meningitis and acute poliomyelitis of the meningeal type is undoubted. In the former

the fluid shows marked turbidity, frequently coarse, purulent clot formation, a great excess of albumin, absence of dextrose, and the meningococcus. Forbes (Lancet, Nov. 18, 1911).

Increase of pressure is the most persistent of the changes in the spinal fluid in poliomyelitis, and does not disappear for several months. After the tenth day it is present in nearly 100 per cent. of cases. Of the fluids examined, 93 per cent. showed an increase in the globulin content and 86 per cent., a pleocytosis. Lymphocytes predominated. Larkin and Cornwall (Arch. of Pediatr., Aug., 1918).

The history of the acute or febrile stage is of import, especially in excluding *cerebral meningitis* and the *cerebral palsies of childhood*. In poliomyelitis there are few irritative symptoms. Convulsions may occur, but the patient does not develop epilepsy or mental enfeeblement. Epilepsy, on the other hand, is often a part of the symptom-picture in the cerebral palsies and mental impairment in some degree almost invariably present. The type of the paralysis in the two is exactly opposite. In poliomyelitis the paralysis is flaccid, the reflexes are lost, the muscles atrophy, the muscles affected are functionally associated, and a monoplegia is the rule as regards distribution. In the true *cerebral palsies* the paralysis is spastic in type, with exaggerated reflexes; no wasting, although arrest of development may result; the paralysis is of muscles anatomically associated; the distribution is usually hemiplegic, monoplegias being rare. In cerebral palsies, too, the cranial nerves, particularly the facial, are often affected and the mind is almost invariably impaired. Finally, there are no electrical changes characteristic of the cerebral palsies.

From *other forms of myelitis* infantile spinal paralysis is to be distinguished chiefly by the frequent absence in the latter affection of sensory symptoms, of sphincter involvement, of bed-sores, of spastic or semispastic phenomena. Palsies from *peripheral neuritis* due to trauma, including so-called *birth-palsies* caused by obstetrical forceps or injury in delivery, are often difficult to distinguish from poliomyelitis. The history of injury to the arm or shoulder and the anatomical distribution of the paralysis are points of differential value. In neuritis of this type sensory disturbances are not conspicuous, as a rule, but may be present. The history as to mode of onset and progress serves to distinguish poliomyelitis anterior acuta from the pure muscular atrophies. Differentiation from *cerebro-spinal meningitis* is at times, especially in endemic outbreaks of either disease, exceedingly difficult. Laboratory methods in the bacteriological examination are in such cases imperative as the only accurate method by which to determine the identity of a given case.

ETIOLOGY.—The pathogenic agent of poliocerebromyelitis has been found by Flexner to be an exceedingly minute organism, emulsions of a virulent spinal cord being still infective after filtration through Chamberland filters. That it is a living organism is shown by the fact that it undergoes reproduction in the body of an inoculated animal, a small amount of emulsion of the spinal cord of a victim of the disease injected into a monkey being sufficient to cause it after a period of incubation of 5 to 46 days. It has not been isolated in pure culture.

It is not only constantly present in the cerebrospinal system, but also in the mucosa of the nasal cavities and pharynx, the salivary, mesenteric, and lymph glands after inoculation, and also in the spinal fluid, and in small quantity in the blood. Animals other than the monkey, with the exception of certain breeds of rabbits, do not appear susceptible to inoculation. Monkeys that recover from the infection show a definite immunity to reinoculation, while their blood-serum deprives an emulsion of virulent spinal cord of all pathogenic power.

The organism probably penetrates the central nervous system after entering the body by way of the nasopharynx or intestinal tract, or both. The secretions of the nose and throat are, therefore, regarded as infectious and capable of disseminating the disease by direct contact. Hence, the fact that the patient should be isolated and kept from school at least three weeks after convalescence. See PROPHYLAXIS below.

The physical properties of the virus adapt it well for conveyance to the nose and throat. Being contained in their secretions, it is readily distributed by coughing, sneezing, kissing and by means of fingers and articles contaminated with these secretions, as well as with the intestinal discharges. Moreover, as the virus is thrown off from the body mingled with the secretions, it withstands for a long time even the highest summer temperatures, complete drying, and even the action of weak chemicals, such as glycerin and carbolic acid, which destroy ordinary bacteria.

Hence mere drying of the secretions is no protection; on the contrary, as the dried secretions may be converted into dust which is breathed into the nose and throat, they be-

come a potential source of infection. The survival of the virus in the secretions is favored by weak daylight and darkness, and hindered by bright daylight and sunshine. It is readily destroyed by exposure to sunlight. Simon Flexner (Address, New York, July 13, 1916).

Ninety per cent. of the acute cases occur within the first decade of life and more than half of all cases within the first three years of life. Among children the two sexes seem about equally susceptible. Among adults it is comparatively rare in the female. The disease is no respecter of caste or class, nor does it manifest any special racial proclivities, though the negro is comparatively exempt and the disease is more common in centers of dense population than in rural districts. Poliomyelitis is often a sequel to the febrile infections of childhood, especially scarlet fever, measles, and diphtheria. In this respect, as well as others, its etiology is quite similar to that of epidemic and sporadic cerebrospinal meningitis. Poliomyelitis may also occur as an epidemic.

In not a few instances trauma appears as the exciting cause; exposure to extreme cold or to excessive or violent exercise may superinduce the disease. The season has its influence, many more cases occurring in summer than in winter. This is especially noticeable in seasons of prolonged excessive heat. Among adults violent exercise, exposure, trauma, debilitating excesses, and syphilis are recognized as potent factors. Heredity is not a factor.

PATHOLOGY.—The essential lesion in acute anterior poliomyelitis is a trophic destruction, more or less complete, of the larger ganglion-cells

(giant cells) of the anterior horns. This occurs as the result of an inflammatory myelitic process disseminated more or less extensively throughout the cord, but chiefly in the anterior gray matter, induced by the Flexner micro-organism, the medium of invasion being the branches of the anterior spinal artery. In the Strümpell and Wernicke types the cortical and basal nuclei or neurons are involved. The cells of the lower dorsal and midcervical segments are most frequently affected. The anterior nerve-roots are also affected secondarily with degenerative changes, and this is true of the muscles to which the affected nerves are distributed. The atrophied muscles show a distinct diminution in the size and number of fibers, the normal tissue being replaced by fat and connective tissue.

PROGNOSIS.—To approximate during the acute febrile stage the extent or degree and the distribution of the final more or less permanent paralysis there is no positive guide, but the severity of the constitutional disturbance, including temperature, is sometimes an index. Occasionally after the constitutional disturbance subsides, the loss of power may remain rather widely distributed. In such instances the electrical response affords information. If the quantitative response grows less or the qualitative change greater from day to day in certain muscles or a limb, just in proportion is there likely to be a permanent residual paralysis. In all cases some permanent paralysis will remain, but it may be six months from the onset before the limits of this paralysis can be determined. The patient is handicapped physically in

after-life to a greater or less extent, but never mentally. The prognosis depends largely upon the ability of the parent to carry out instructions in faithful, patient, persistent treatment. Recoveries range from 7.1 per cent. (New York epidemic) to 19.2 per cent. (Minnesota epidemic).

In poliomyelitis proper the prognosis as regards life is almost invariably good. In the polioencephalitic type a fatal result has been frequently noted, and this is true of certain endemic outbreaks, a variable virulence in the micro-organism affording the probable explanation.

The *prognosis* as to life is good in sporadic cases; in epidemics the mortality is frequently 12 per cent., and in some may rise as high as 40 per cent. Hochhaus (Münch. med. Woch., Nov. 16, 1909).

PROPHYLAXIS.—Flexner holds that the United States has suffered disproportionately and more severely than Europe in its epidemics of poliomyelitis because the disease was often unrecognized, and there were no authoritative sanitary regulations to enforce quarantine. Most attention should be paid to prevention. Human transmission, both by those actively infected and those who are about the ill, occurs frequently. Hence there must be quarantine of the sick and of those in attendance on the sick. Cases of long persistence of the active virus in the monkey are cases of chronic bacteria carriers. A period of isolation of three to four weeks is necessary even in ordinary cases. The nasal and buccal secretions of those affected with poliomyelitis must be especially well cared for, as in them is probably the chief source of infection, although all the

excretions must also be aseptitized. Domestic animals may serve as reservoirs for the virus. Flies may harbor the virus on their bodies or in their viscera. Recovery from the disease is effected by means of immunizing principles in the blood. Sera obtained from animals subjected to injections of spinal cord and brain of monkeys containing the living virus are relatively weak in antibodies, and will be of little aid in cases of developed poliomyelitis in human beings. The only drug recommended is **hexamethylenamine**.

Once in the air the virus may be disseminated in various ways, by direct contact with clothing, by the wind, and by water. As prophylactic measures, washing down and oiling the streets, antiseptic scrubblings of rooms, spraying the nasopharynx with **hydrogen peroxide** in persons exposed, a strict quarantine for at least two months, prohibition of bathing in stagnant water in a neighborhood where a case occurs, as well as of playing around sand-heaps, and thorough disinfection of domestic animals are recommended. M. Neustaedter (Jour. Amer. Med. Assoc., Sept. 7, 1912).

The writer emphasizes the need for greater care in the prevention of the spread of the disease by the use of (1) dilute **hydrogen peroxide** or 5 per cent. **menthol nasal irrigation** for those exposed; (2) **disinfection** of the **patient's stools and urine**; and (3) **isolation** of the patient for six weeks and of other members of the household for three weeks. G. W. Howland (Can. Jour. Med. and Surg., xxxvii, 52, 1915).

Practical demonstration of the fact that the active virus of poliomyelitis may occur in rectal washings obtained from a patient fourteen days after the beginning of the paralysis. Since the virus may leave the body from the rectum, as well as from

the nose and mouth, precautions should be taken in the care of poliomyelitis patients to prevent infection from feces and soiled bedding. W. A. Sawyer (Amer. Jour. Trop. Dis. and Prevent. Med., Sept., 1915).

The chief means by which the secretions of the nose and throat are disseminated is through the act of kissing, coughing, or sneezing. Hence during the prevalence of an epidemic of infantile paralysis, care should be exercised to restrict the distribution as far as possible through these common means. Habits of self-denial, care and cleanliness and consideration for the public welfare can be made to go very far in limiting the dangers from these sources.

Moreover, since the disease attacks by preference young children and infants, in whom the secretions from the nose and mouth are wiped away by mother or nurse, the fingers of these persons readily become contaminated. Through attentions on other children or the preparation of food which may be contaminated, the virus may thus be conveyed from the sick to the healthy.

The conditions which obtain in a household in which a mother waits on the sick child and attends the other children are directly contrasted with those existing in a well-ordered hospital; the one is a menace, the other a protection to the community. Moreover, in homes the practice of carrying small children about and comforting them is the rule, through which not only the hands, but other parts of the body and the clothing of parents may become contaminated.

Flies also often collect about the nose and mouth of patients ill of infantile paralysis and feed on the secretions, and they even gain access to the discharges from the intestines in homes unprotected by screens. *This fact relates to the domestic fly, which, becoming grossly contaminated with the virus, may deposit it on the nose and mouth of healthy persons, or upon food or eating utensils. To what*

extent the biting stable-fly is to be incriminated as a carrier of infection is doubtful; but we already know enough to wish to exclude from the sick, and hence from menacing the well, all objectionable household insects.

Food exposed to sale may become contaminated by flies or from fingers which have been in contact with secretions containing the virus; hence food should not be exposed in shops and no person in attendance upon a case of infantile paralysis should be permitted to handle food for sale to the general public.

Protection to the public can be best secured through the discovery and isolation of those ill of the disease, and the sanitary control of those persons who have associated with the sick and whose business calls them away from home. Both these conditions can be secured without too great interference with the comforts and the rights of individuals.

Where homes are not suited to the care of the ill so that other children in the same or adjacent families are exposed, the parents should consent to removal to hospital in the interest of the sick child itself, as well as in the interest of other children. But this removal or care must include not only the frankly paralyzed cases, but also the other forms of the disease.

In the event of doubtful diagnosis, the aid of the laboratory is to be sought, since even in the mildest cases changes will be detected in the cerebrospinal fluid removed by lumbar puncture. If the effort is to be made to control the disease by isolation and segregation of the ill, then these means must be made as inclusive as possible. It is obvious that in certain homes isolation can be carried out as effectively as in hospitals. Simon Flexner (Address, New York, July 13, 1916).

TREATMENT.—No material progress has of late been made in the treatment of the disease.

During the febrile stage the treatment is that for all forms of acute myelitis, including **absolute quiet and rest, ice-bags or counterirritation** to the spine, **laxatives**, and a **non-stimulating, easily digested diet**. To these measures should be added, if there is much fever, antipyretics, such as **phenacetin** or other coal-tar derivatives. It is customary to use **ergot** in $\frac{1}{2}$ -dram (2 Gm.) doses or less, with or without **bromide of potassium**, and no harm is likely to follow its employment. The **salicylate of soda** has been employed with some advantage in epidemics of the disease, and its use seems rational. Administration of **hexamethylenamine** in full doses has been advised throughout the acute stage. In Flexner's experiments on monkeys, however, the drug proved effective only very early in the course of the inoculation, and in only a part of the animals treated. The dose should be 2 grains (0.13 Gm.) every six hours for a child of 2 or 3 years of age; 3 grains (0.2 Gm.) at 6 to 10 years, and 5 grains (0.3 Gm.) for adults.

Among 77 cases treated with **adrenalin**, as recommended by Meltzer, there were 18 deaths, of which but 5, or 6.9 per cent., are considered failures of the adrenalin treatment. The bottle of 1:1000 solution was first placed in a bath of boiling water to drive off the chlorotone. Spinal puncture was made between the fourth and fifth lumbar vertebrae, intraspinal pressure relieved, and 2 c.c. (32 minims) of the adrenalin solution injected. This was repeated every 6 hours day and night until the temperature was normal. P. M. Lewis (Med. Rec., Sept. 23, 1916).

In epidemics, as a measure of prophylaxis, careful attention should be given to the hygiene of the nasopharynx, **intranasal antiseptic solu-**

tions being indicated. A 1 per cent. **hydrogen dioxide solution** should be used as spray and gargle by the patient and the members of his family. **Argyrol** (25 per cent.), **protargol**, **chinosol** (1:2000), or **colloidal silver** are also available for this.

Efforts to immunize by **bacterial sera** have not been as yet successfully perfected, although Flexner's work in this direction has seemed to promise much for the future.

The writers deem it established for monkeys, and probable for man, that intraspinal injection of **immune serum** in poliomyelitis is curative. Flexner and Amoss (Jour. of Exper. Med., Apr., 1917).

Report of 26 cases treated with large amounts of **serum** obtained from **persons recently recovered** from poliomyelitis. Apparently the best results were obtained in cases treated within 30 hours. Amoss and Chesney (Jour. of Exp. Med., 25, 581, 1917).

An **immune serum** of high titer was prepared by repeated inoculation of the horse with the coccus of anterior poliomyelitis and used in 159 cases. The mortality was 12 per cent., as against 32 per cent. in the untreated. Ten patients were treated in the pre-paralytic stage, and all recovered without paralysis. The serum arrests the progress of paralysis when developing. It was given intraspinally by the gravity method after withdrawal of spinal fluid, the dose being 5 to 10 c.c. for a child. Simultaneously from 10 to 30 c.c. were given intravenously. The injections were repeated at intervals of twenty-four hours. J. W. Nuzum and R. G. Willy (Jour. Amer. Med. Assoc., Oct 13, 1917).

Treatment of poliomyelitis with **immune horse serum** applied in 58 cases. Altogether, 94 intravenous injections were made. In no instance was a primary toxic action noticeable, and in only 6 was there later evidence of serum disease. Ten patients died,

a mortality of 17 per cent. Excluding 7 already moribund, there were but 3 deaths. Of 23 untreated patients, 9 died. Paralysis never developed when treatment was begun before its onset. No extension of existing paralysis occurred. Rosenow (Jour. of Infect. Dis., Apr., 1918).

The antistreptococcic serum of Nuzum and Willy has failed to show in the monkey neutralizing or therapeutic power when applied by the writers' methods against small doses of the virus of poliomyelitis. Under the same conditions the serum of monkeys recovered from experimental poliomyelitis proved neutralizing and protective. Amoss and Ebersson (Jour. of Exper. Med., Sept., 1918).

The writer applied the therapeutic test devised by Amoss and Ebersson to fresh samples of immune horse serum prepared by injections of the poliomyelitic coccus in the horse. Three monkeys were completely protected while the fourth developed mild symptoms and recovered completely. The control monkeys receiving normal horse serum all died. Fresh immune horse serum protected perfectly against infection, while pooled immune monkey serum served only to delay the onset of a fatal infection. Nuzum (Jour. of Infect. Dis., Sept., 1918).

For the permanent residual paralysis our most reliable therapeutic resources consist of **electricity, massage, and exercise of the parts** through the assistance of various mechanical appliances to be appropriately devised by the orthopedist. Both currents should be employed. In using **galvanism** one electrode, a large flat pad, should be placed over the spine at the level affected, the other on the limb paralyzed. Not more than 3 to 5 milliamperes should be used at first. As the child becomes accustomed to it, the current-strength may be gradually increased. The *séance* should

last twenty minutes daily, and should be followed by an application of the **faradic current** to the limb itself. The current here should be strong enough to produce gentle contractions. If there is no response to faradism except with painfully strong currents, the interrupted galvanic current may be used in the same way. As much as possible of the affected muscle should be included in the circuit.

Massage should be given, preferably by one qualified for the work, though, if an expert be not available, simple rubbing is of at least some service in stimulating the circulation and local nutrition. **Strychnine** internally is at times of apparent value. The amount should vary with the age, of course, but much larger doses than are ordinarily prescribed are indicated. Such large doses may be quite safely reached by a gradual increase. **Splints, braces,** and other appliances serve a useful purpose in preventing crippling contractions and unsightly deformities. A flaccid leg may be supported by a brace so as to become useful in walking, which in itself is a valuable therapeutic aid. **Velocipedes, tricycles,** and other similar machines are often of much service.

The employment of re-educational and **developmental exercises** with muscle training, direct or vicarious, should be much more extensively and hopefully employed. Much more is to be accomplished remedially by such methods than by the prolonged employment of fixation apparatus, braces, and other supportive devices.

Operative Treatment.—Considerable work in this direction has been done in recent years. Besides efforts to correct deformity and improve

muscular function referred to above, tendon transplantation, insertion of bone, insertion of periosteum, arthrodesis or the production of artificial ankylosis and other operations have been employed. As these belong to the field of the orthopedic surgeon, a recently published report by Dr. R. Tunstall Taylor (*New York Medical Journal*, January 29, 1916) is submitted:—

Tenotomy and Myotomy.—Orthopedists daily now employ them in correcting deformities by severing the overactive muscles and lengthening them thereby; this overactivity is due to a parietic condition in the antagonist or antagonistic group as explained by Seligmüller's theories. These operations are of distinct benefit, in that they not only restore the normal alignment in the members, but relieve the remaining weakened living muscular fibers in the parietic muscle from overstrain, which in itself is a detriment. As a rule, some mechanical device to prevent recontraction of the overstrong muscle is required in the after-treatment of all cases.

Tendon shortening by taking a tuck in it by suture, tying, or removal of a section has been done by various surgeons in the past.

Tendon lengthening has been accomplished more often by tenotomy subcutaneously within the sheath, and lengthening has occurred by organization of the plastic exudate between the severed ends. Some few authorities prefer lengthening the tendon by oblique section and suture through an open incision. Again, others prefer to lengthen by the Bayer Z section and then stretching. Again we find some, instead of cutting the tendon transversely, cut it from below upward and forward through the width of the tendon to get a broader surface for sewing.

Tenodesis was a procedure advocated by Hoffa and extensively used by him, of converting the tendons around a joint into ligaments by sewing them above and below a joint, to increase its stability when flail-like and to restore proper alignment and balance when distorted.

Gallie's recently presented operation is akin to Hoffa's tenodesis in that he endeavors to secure more thorough joint fixation by using a whole or a part of a tendon near the ankle to produce a tendon fixation into the bone, which he has grooved with a gouge to sufficient depth to suture and bury the tendon and to cover it with the incised and elevated periosteum.

Extra-articular silk ligaments, chiefly to support a flail ankle, knee, or shoulder have been advocated by Lange and Allison. The former has preferred silk ligaments to arthrodesis since 1903 and introduces from 6 to 8 strong silk threads sutured to the periosteum of the scaphoid and tibia and cuboid and fibula, having been passed through the adipose tissue from point to point. The upper point of attachment is 5 cm. above the ankle-joint.

Allison uses the silk as a stirrup. With a drill having an eyelet which he threads, he passes the silk through the anterior tarsal bones from side to side of the foot, then threads a probe, which he passes under the annular ligament up to the crest of the tibia, where he makes an incision and sutures the two ends to the periosteum. Similarly, he threads the os calcis and passes the ends up for suture in the posterior aspect of the tibial periosteum.

Intra-articular Silk Ligaments.—Bartow and Plummer describe artificial ligaments of silk which are both intraosseous and intra-articular, passed into and through joints in the desired direction to restrict or limit motion, to be used exclusively in flail joints. It is especially adapted for use at the knee, ankle, and shoulder, using 14-20 Corticelli silk. Allied somewhat, only so far as the effect obtained is concerned, is the operation of Robert Jones for flail elbow, where we have a useful band which is valueless when the arm hangs at the side. He removes a diamond-shaped flap of skin from the front of the elbow, of sufficient size so that the two equal triangles which go to make up the diamond when approximated and sutured, will hold the forearm at 40 degrees with the arm, the most useful angle.

Arthrodesis for flail joints was described at length by Townsend and Goldthwait in

excellent articles which will be found in the *Transactions of the American Orthopedic Association*. This procedure, especially for the ankle, has many warm advocates, as it enables the paralytic in many cases to do without a brace. It is employed also at the shoulder in deltoid paralysis and at the hip and knee rarely; never at the hip, knee, and ankle of the same subject. H. Augustus Wilson strongly advocates this procedure.

Articular Transposition.—Gwilym Davis has devised an ingenious and efficient operation for paralytic talipes calcaneus in which he makes a transverse horizontal section through the os calcis just below the articular surface adjacent to the astragalus. He then slides the heel back and the tibia, fibula, and astragalus forward, so that the weight comes upon the anterior portion of the os calcis, and calcaneus is impossible. This procedure I have classified as "articular transposition." His results are excellent.

Astragalectomy.—Whitman has been the author and chief advocate of astragalectomy for talipes calcaneus. After removal he slides the tibia and fibula forward, and the recurrence of calcaneus is practically prevented as in Davis's operation. The mutilation, prevention of other motions, and shortening of the limb are its chief objections, but the gait secured is excellent and the deformity is corrected.

Nerve Anastomosis.—This procedure has been successful in secondary suture after traumatic section of nerves, and in facial paralysis. Spitzzy was successful experimentally in dogs' legs, in anastomosing nerves both centrally and peripherally, and Howell anastomosed flexor nerves into extensor and *vice versa* in dogs' legs, but neuroplasty has failed to meet expectations in anterior poliomyelitis, when the peripheral end of a paralyzed nerve was sutured into a functioning nerve or a slip from a functioning nerve was attached to a paralyzed nerve. There is evidently a general impairment in all the nerves in a partially paralyzed extremity, and a nerve anastomosis is like taxing an already weak and run-down battery with more work.

Tendon Transplantation on Tendon.—It consists in the attachment of the distal

tendon of the weakened muscle to one still alive and functionally active, to help restore support and use to the paralyzed tendon, but only in rare instances have these cases yielded results which enabled the patient to do without artificial support. Dane's statistics of 50 cases from the Children's Hospital, Boston, were discouraging, as were reports from elsewhere in this country and abroad.

Tendon Transplantation to Periosteum.

—Since 1899, by means of the new method of Lange, as it is called, in contradistinction to the older method of Nicoladoni, we suture the tendon to the periosteum or a silk prolongation of the tendon to the periosteum, or actually pass the tendon through a bony canal, or sew it to the bone, or reduplicate it on and suture it by Ryerson's method to itself. This seems to have maintained the desired muscular tension much better and to have accomplished the aim we have in view more satisfactorily in the writer's hands, and, as reported, by Hoffa, H. Augustus Wilson, Dane, Le Breton, and others.

Elongation of short tendons by means of silk sutures—preferably white sublimated—coated with paraffin, and giving these a periosteal attachment, has also yielded good results in my experience. Auger first used silk to lengthen tendons in 1875, to which Lange calls our attention, but Lange popularized its use.

The following operation has been constantly employed by me since 1909 and in some 300 cases of leg and foot paralysis: The tendon must be carried straight from the origin to the new insertion to gain the greatest mechanical efficiency, and the annular ligament must be employed when possible to take up any slack in the new order of things. The tendon is more securely fixed if sutured to a notch in the bone, retained in a fixed dressing for 4 months, and without weight bearing for 2 months.

MYELITIS.

SYNONYMS.—Inflammation of the spinal cord; softening of the spinal cord.

DEFINITION.—Myelitis is an inflammation, localized or general, with

secondary softening or sclerosis of the spinal cord, with irritative and paralytic motor and sensory as well as special symptoms, varying in character and distribution with the localization and degree of the morbid process at different levels or areas of the cord. Many varieties are recognized. The anatomical division includes the cervical, dorsal, and lumbar varieties; the transverse (imperfect or complete); the diffuse, or disseminated; the focal; the central; and the marginal. The last mentioned is frequently associated with and often dependent upon a meningitis, the resultant condition being known as meningomyelitis. The etiological division includes at least three varieties of importance: the traumatic, the syphilitic, and the tubercular. The terms acute, subacute, and chronic appear in the literature, although Strümpell and others dispute the existence of a primary chronic myelitis. The type of all forms is acute transverse myelitis.

SYMPTOMS.—The disease may begin abruptly, subacutely, or very gradually. When the onset is abrupt a chill may occur, followed by fever, the temperature ranging from 101° to 104° F. (38.3° to 40° C.), occasionally higher. In children the onset may be attended with convulsions; aside from the general malaise and fever, the constitutional disturbance may be slight.

The essential nervous symptoms are usually irritative at first, although motor and sensory paralysis may be present from the start. These nervous symptoms vary widely with the locality and extent of the myelitic process, imperatively necessitating a certain degree of familiarity with the

topographical anatomy and functional localization of the cord. The dorsal region is most frequently affected in the focal disease. Among the irritative symptoms hyperalgesia and hyperesthesia are common. The patient may complain, sometimes emphatically, of pain in the back and legs. Quite often the sensation is that of a tired aching in the limbs, as from excessive fatigue. If up and walking about, the legs are lifted wearily and the patient refers to them as being weighted with lead. There is a subjective numbness, or various paresthesie may be mentioned. The bladder is disturbed in function. There is retention, or the urine may dribble involuntarily. The bowels are usually obstinately constipated; less frequently there is incontinence of feces. Sexual power is lost or there may be persistent priapism. A feeling as of a band or belt encircling the hips, the waist, or the chest may be present. This is the so-called *ceinture*, or girdle symptom, and is quite constant in myelitis. The level of the *ceinture* feeling is a guide to the level of the cord-lesion. If the disease is of the cervical cord, involving the origin of the brachial plexus, the arms will be affected. Pupillary changes are also frequently noted when the disease is of the cervical cord through implication of Budge's ciliospinal center.

Case characterized by an acute ascending paralysis, commencing with indications of meningitis in the form of acute pain and spinal rigidity. Vision was impaired on the following day, and on the day after this evidence of slight panillitis, more on the right side, was observed. The upper limit of hyperesthesia was one inch below the nipples. On the ninth day of illness the breathing was almost entirely abdominal, but the arms

could be easily moved. On the fourteenth day marked dysphagia set in, and the patient died while attempting to swallow fluid. E. F. Clowes (Lancet, Mar. 23, 1912).

Should the myelitis extend upward the functions of the vagus are disturbed and dyspnea, with circulatory and vasomotor symptoms, is added to the picture. Following the irritative come the paralytic symptoms. The hyperesthesia is succeeded by anesthesia, which is characteristically erratic in distribution. Any or all other forms of common sensation may be impaired or completely lost. There may be dissociation of sensation.

The motor weakness is succeeded by actual paralysis, which follows an anatomical distribution, but is usually not absolute. This paralysis may be flaccid or spastic, or first one and later the other, with abolished or exaggerated reflexes according to the location of the lesion. Widespread motor and sensory paralysis may follow slowly a prolonged irritative stage or it may be extensive and complete in a few hours or days. Within a few weeks or months atrophy of the muscle, sometimes slight, sometimes extreme, occurs. The electrical reactions may remain normal, although both quantitative and qualitative changes have been frequently noted. Bed-sores are exceedingly common in severe cases, and are sometimes an extremely dangerous symptom.

In the spastic cases decided contractures may develop, the knees being flexed upon the abdomen, the heels touching the buttocks. Clonic or tonic spasms occurring in exquisitely painful paroxysms add to the sufferings of the patient in many

instances. In the chronic variety of the disease the irritative symptoms are far less prominent. The mind remains unaffected in all cases except where an insanity may be superadded from pain and abject helplessness. It should be remembered, too, that the syphilis or tuberculosis or alcohol causing a myelitis may later attack the brain.

Case of a man of 50 with a history of syphilis. He began to experience pain in the spine, and after a few days there was sudden and total paralysis of the legs, but no flaccid paralysis. The spine was painted with tincture of iodine, while vigorous mercurial treatment was instituted and by the fifth day the man was taking a few steps and soon was able to return to business. Britto (Brazil Medico, Nov. 15, 1914).

Case of myelitis in a child of 5½ years, who had complained of vague pains in the chest and legs. There was paralysis of both legs and back with anesthesia extending from the toes to a line drawn around the chest just below the nipples. The temperature, previously fairly normal, rose just before death. The heart and lungs remained normal. There was no history of any infectious fever, which is the rule in these cases. The etiology of this case is obscure. H. T. Ashby (Brit. Jour. Child. Dis., May, 1915).

DIAGNOSIS.—The acute disease may occasionally closely resemble *Landry's paralysis*. In the latter affection the sensory symptoms are slight; usually there are no bladder or rectal symptoms, no girdle sensation, and the course of the disease is, as a rule, much more rapid. Certain types of multiple neuritis are occasionally temporarily confusing. This is especially true of the cases of myelitis inducing flaccid paraplegia or diplegia. In such cases, however,

pain is much less conspicuous than in neuritis, and in the latter the sphincters are not involved. Bed-sores and other trophic lesions are rare in neuritis.

Spinal meningitis rarely exists alone, the cerebral meninges being usually simultaneously involved. In *syphilitic* or *tubercular spinal pachymeningitis* or *leptomeningitis*, the pain is usually much more conspicuous and the irritative spasms more decided. Usually, however, the cord is soon involved, and the differentiation is unimportant.

Occasionally *tubes* is suggested. The knee-jerks may be abolished or greatly diminished, the genital functions are involved, the sensory symptoms may be similar, Romberg's symptom may be present, and there may be an ataxic gait. The Argyll-Robertson pupil will be found wanting, however, as well as other ocular and optic-nerve changes; the pains are different in character and degree, and there is true motor paralysis.

The history as regards mode of onset and rate of progress is of value in differentiating *spinal muscular atrophy* and *amyotrophic lateral sclerosis* and *primary lateral sclerosis* from myelitis. *Tumor of the cord* is almost invariably complicated with myelitis of focal type, and the symptoms are necessarily identical in great measure. It is possible, however, to determine the existence of tumor at times by the more intense and sometimes agonizing pain, the slower rate of progress, the narrower limitation of symptoms, and the lessened degree of constitutional disturbance. The presence of tumor elsewhere, especially if malignant, is often of assistance. The X-ray is of very infre-

quent value in suspected cord tumor in my experience. Its employment is none the less indicated as a routine procedure in suspected cases. *Spinal hemorrhage*, if at all extensive, is usually quickly fatal from shock.

Case in which the symptoms of the myelitis changed, showing that the lesion had migrated. Patient was a robust mechanical engineer of 30, who ran a rusty nail into one toe and a month later had to work in icy water all one night. The motor paralysis, motor irritation, disturbances in sensibility and in the reflexes were at first those typical of myelitis in the lower spinal cord, but then these subsided and others developed indicating transference of the lesion to a region higher up. Among the most disturbing symptoms in the later phase were the unbearable itching from axillae to ears, including the arms, and also the headache. Invasion of the medulla oblongata was momentarily expected, but under intramuscular injections daily of 10 c.c. (2½ drams) **camphorated oil**, with **strychnine** and **aspirin**, a marked turn for the better was noted, and with continued **galvanization**, strychnine injections and **carbonated baths** a clinical cure followed, even the cremaster and abdominal reflexes returning. In less than three months from the first symptoms the patient felt entirely well. Bing (Med. Klinik, Dec. 15, 1912).

ETIOLOGY.—The disease may occur at any age and in either sex, though it is most common in males between the ages of 15 and 40 years. Prolonged or severe exposure to cold and dampness is a frequent and potent etiological factor. Next in frequency and importance, perhaps, is trauma, including excessive physical effort or exertion.

Case of myelitis first manifesting itself two days after a severe fright from burglars; the patient had pre-

viously suffered from an attack of facial paralysis from which he seemed to have perfectly recovered. The case terminated fatally, and necropsy showed extensive organic disease in the lumbar cord. Cases of paralysis from fright have usually been attributed to hysteria. The patient also suffered from perirectal infection, and septicemia was given as the cause of death. W. G. Spiller (Jour. Amer. Med. Assoc., Oct. 31, 1914).

A relatively large number of cases are due to syphilis, which may act either directly or remotely as cause. Even in cases where an obvious trauma or other etiological factor is present, a Wassermann should be done as a matter of routine. The co-existence of syphilis may modify both prognosis and treatment in cases due to other exciting causes.

Case in a girl of 17 with both gonorrhea and syphilis; three months after the development of the syphilitic eruption she began to have fever, headache and paresis of the legs, blending into total paraplegia of the ascending type, fatal the fifteenth day. The findings in the spinal cord were those characteristic of acute poliomyelitis, but the symptoms had been more those of Landry's paralysis. A tetragenus in pure cultures was obtained from the blood and cerebrospinal fluid, and this germ was evidently responsible for the syndrome observed. Catola (Policlinico, Jan., Med. Sec., 1911).

Tuberculous myelitis is rare, though spinal meningitis due to tuberculosis with secondary complicating invasion of the cord is not uncommon. Occasionally myelitis occurs during or immediately following (*propter hoc*) the acute infectious diseases. Arsenic, lead, and other metallic poisons may induce the disease.

A toxi-infectious myelitis may run an absolutely latent course, and be

merely a necropsy surprise. In other cases, the only sign may be exaggeration of the foot and knee tendon reflexes. This was found manifest in 60 of 100 typhoid patients, also in cases of pneumonia, miliary tuberculosis and neurasthenia. In 4 cases of the latter, after influenza, this was the only spinal symptom. S. Bernheim (Revue de méd., Jan., 1912).

Gross alcoholic excess is often a most important contributing factor and may occasionally prove the sole cause. In a very appreciable proportion of patients the etiology cannot be positively determined. This is especially true in subacute and chronic myelitis.

Case of poliomyelitis in a young woman of 18 years, in whom gradually, over a period of three days, developed symptoms of a complete transverse myelitis involving about the middle of the dorsal cord. Improvement was noticed on the sixth day, and recovery was practically complete in about seven weeks. B. S. Sachs (Jour. Nerv. and Mental Dis., Nov., 1912).

Case in which at operation the cause of the compression was found to be a vertebral sequestrum, 3 cm. long, which had penetrated into the spinal canal and was surrounded by fibrous adhesions. The operation was followed by an excellent functional result. Mandler (Münch. med. Woch., Nov. 5, 12, 19, 1912).

PATHOLOGY.—The morbid anatomy of myelitis varies with the cause of the disease somewhat and to a still greater degree with the stage during which death occurs. In patients dying during the acute stages the appearance of the cord in the areas affected is that of an acute inflammatory process. Punctiform or capillary hemorrhages are sometimes present. The cells are swollen and

the nuclei distorted or displaced. These changes are followed by an increase of connective tissue, with destruction of the nerve-cells and nerve-fibers. The cord may be discolored and swollen in appearance on gross inspection or it may appear shrunken. Later the vessel-walls become thickened; the nerve-tissue is more or less completely displaced by connective tissue; the cells disappear and are replaced by granular and amorphous material. The pia and even the dura may be involved. In some instances, especially those due to syphilis, the entire cord for several inches may be so softened as to be diffuent. The nerves may participate secondarily in the degenerative process.

In most cases of acute myelitis, and also of acute poliomyelitis, the affection is caused, not by an inflammation, but by thrombosis of some of the vessels of the spinal cord (where, in the latter disease, it is not due to a special acute degenerative process). This conclusion is rendered obvious by the similarity of the morbid changes in question to those occurring in the brain which are due to thrombosis, as well as to the absence of any reason why a primary inflammation should be rare in the brain and common in the spinal cord. Bastian (*Lancet*, Nov. 26, 1910).

PROGNOSIS.—This varies widely in individual instances. Myelitis due to causes which are removable by surgical procedure—as, for example, compression from trauma, tumor, or vertebral disease—may occasionally be completely cured. Syphilitic myelitis offers a distinctly better prognosis than the non-syphilitic, although even here an opinion as to the outcome should always be extremely guarded. Immediate danger as regards life is

greatest in myelitis due to or following the infectious fevers, sepsis, and severe injury. The duration of the disease is equally indefinite; a sub-acute myelitis may pass into a chronic, slowly progressive form, the gradual development of symptoms extending over a period of many months or years. The inflammation may subside after a varying length of time and be followed by a necrosis or sclerosis which is limited by the preceding inflammation, the patient being left with a paralysis which remains permanently stationary. The process may stop and then start up again, some slight additional cause relighting the fire in a locality predisposed by previous disease. The severity of the trophic symptoms is quite reliable as a guide in determining the immediate danger to life, deep and extensive bed-sores being invariably of ill omen. Severe bladder symptoms are also of evil significance.

TREATMENT.—Absolute rest in bed is essential in all cases; at first counterirritation should be employed, with extreme caution, on account of bed-sores. A water-bed is often advisable from the first to prevent this complication. The catheter should be employed also with extreme antiseptic and mechanical precaution. Pain should be relieved by opiates when necessary, but in minimum doses. In syphilitic myelitis the patient should be put at once upon full and rapidly increasing doses of potassium iodide. The dose to begin should be at least 25 drops of the saturated solution. The salt should be pure and the vehicle should be changed every few days—water, milk, Vichy, Apollinaris, Giesshübler water, or plain carbonated water may be em-

ployed in turn. The dose should be progressively diluted more and more, as it is increased. Should iodism develop, double the dose if less than 40 drops or grains; if over 100, reduce it one-half and rapidly increase to a dose beyond that at which iodism occurred.

The maximum daily amount is to be determined by the effect on the disease, but it is rarely necessary to give more than 600 or 800 grains (40 or 53 gm.) daily.

Mercury is superior to the iodide only when primary syphilis has immediately or at least recently preceded the myelitis, but both drugs should be used in every case, either alternately or in conjunction. The immediate gain from the use of **neosalvarsan** should not be relied upon, but should be **followed up with mercury** promptly.

Syphilitic meningomyelitis and encephalitis, or even gummata, should be most responsive to direct medication by one of the methods of **intra-spinal** or **subdural introduction**.

When the disease results from trauma or is due to tumor, abscess, or disease of the *vertebræ*, the question of operative interference should always be considered and decided promptly in order to prevent extension and secondary softening.

Symptomatic relief may often be obtained by appropriate **operative treatment**, and this is true even in tuberculous myelitis, where **lumbar puncture** with drainage at times greatly alleviates the patient's distress. In myelitis due to infection there is no specific drug or plan of treatment. **Sodium salicylate**, small doses of **mercury**, or full doses of **iron** may be given in addition to the

familiar local measures during the acute stage. **Hexamethylenamine** has come into vogue as a routine drug in all cases due to trauma or infection.

For the chronic disease we may expect a certain amount of benefit from **galvanism** and **massage**. (See **POLIO-MYELITIS**). **Silver, arsenic, gold, phosphorus**, and **ergot** are all mentioned as therapeutic resources, but there is little, if any, evidence of specific benefit from either. A tentative course of treatment with **potassium iodide** should be given in all chronic cases.

AMYOTROPHIC LATERAL SCLEROSIS.

DEFINITION.—Amyotrophic lateral sclerosis is a disease characterized essentially by the two symptoms of spastic rigidity and muscular atrophy.

SYMPTOMS.—The clinical history of the disease is quite constant. It begins very insidiously. Usually the earliest symptoms are referable to the disease in the anterior horns, and are similar to those of incipient progressive spinal muscular atrophy: wasting of the thenar and hypothenar muscles, of the interossei or of the muscles of the arms or legs, almost always symmetrically, with or without tremor, which is rarely fibrillary, however. The degree of wasting may be slight, or it may be readily mistaken at this stage for some form of progressive muscular atrophy.

Within a few weeks or months, or, it may be, simultaneously, a sense of unusual fatigue upon exertion, with muscular stiffness and increasing difficulty in walking or in using the arms, due to the developing spastic rigidity, is noted, and the patient seeks advice. On examination, in

addition to the atrophy, which is often more perceptible to touch than to vision, the limbs will be found more or less rigid and resistant to passive motion, giving the examiner a sensation as of bending a lead pipe. The knee-jerks and other deep reflexes will be found markedly exaggerated, and often early in the disease, and always in the well-established disease, ankle-clonus and wrist-clonus are readily elicited. If the bulbar nuclei are involved, there may be wasting of the muscles of the face, with alteration in the expression and impairment of speech, respiration, deglutition, and cardiac action.

A symptom of importance is the altered electrical reaction to both the faradic and galvanic currents. The muscles respond more and more feebly to faradism. Qualitative changes with the galvanic current are present early, and it is not uncommon to find decided alteration of the normal polar formula, with reaction of degeneration within a few weeks or months. In the late stages of the disease the atrophic symptoms may dominate the picture, the rigidity disappears, the reflexes are lost, and the victim is bedridden, but with unimpaired intelligence.

In some cases of amyotrophic lateral sclerosis, the symptoms and signs suggest nothing more than a progressive muscular atrophy of the Aran-Duchenne type, the sclerosis of the anterolateral columns, characteristic of amyotrophic lateral sclerosis, not being manifested in any very distinct symptoms. In the case reported by the authors, there was noted, in addition to the Aran-Duchenne syndrome, merely a slight exaggeration of the tendon reflexes in the four limbs, a temporarily positive Babinski, a few brief attacks of

rigidity and pain at long intervals, and only at the last a trace of muscular contracture. Yet the patient died about twenty months after admission, and the spinal cord showed a typical lateral sclerosis. Such a case demonstrates the importance of paying heed to even minor spinal signs in the diagnosis of amyotrophic lateral sclerosis. A. Gonnet and A. Grimaud (Lyon méd., Apr. 19, 1914).

DIAGNOSIS.—The diagnosis is a matter of no difficulty ordinarily. The picture is that of primary lateral sclerosis and progressive spinal muscular atrophy combined. From other forms of myelitis and sclerosis presenting one or both of these symptoms, this disease is distinguished by the usual absence of sensory symptoms and of sphincter involvement.

ETIOLOGY.—It is not at all a common affection, is seen oftenest during middle adult life, and affects males chiefly. The etiology is not definitely understood, although traumatism, exposure to extreme cold, and excessive physical exertion, if prolonged, are probable auxiliary factors etiologically.

Two cases in which amyotrophic sclerosis developed after an injury to the hand in 1 case, and after a severe strain, followed some months later by a fall, in the other. There is only a reasonable presumption of trauma as an etiological factor, definite proof being lacking. A. H. Woods (Jour. Amer. Med. Assoc., June 24, 1911).

PATHOLOGY.—The pathology, on the contrary, is unusually well defined and constant. In the spinal cord the lesions are found in the anterior horns and in the lateral and anterior pyramidal columns. In the anterior horns the lesions are practically identical with those observed in chronic poliomyelitis. The so-

called giant cells are either atrophied or destroyed altogether. In the motor tracts, both lateral and anterior, there is in all cases a well-marked sclerosis of these fibers, extending throughout their entire length, often into and beyond the pons and occasionally even to the subcortical motor fibers of the Rolandic area itself. If the pontobulbar region is involved, the motor nuclei show degenerative atrophy exactly as do the cells of the anterior cornua. The peripheral nerves also undergo degeneration, which is of the parenchymatous type. In the muscles the essential fibers are replaced by connective tissue and fat, the alteration in color and consistency being often readily apparent.

PROGNOSIS.—The prognosis is hopeless as to cure. Early helplessness is the rule, and death occurs within a few years, though a fatal termination may be delayed by an induced or spontaneous remission or arrest of progress.

TREATMENT.—Our therapeutic efforts are limited by experience to purely palliative measures. Among these, **rest, massage, electricity, and hydrotherapy** are all of value. The victims of this disease should be considered legitimate subjects for therapeutic experiment.

PRIMARY LATERAL SCLEROSIS.

SYNONYMS.—Spastic spinal paralysis; spastic paraplegia.

DEFINITION.—It is a disease of gradual progressive onset assumed to be dependent upon a primary sclerotic affection of the lateral pyramidal tracts or columns, with symptoms of motor paralysis of spastic type, exaggerated reflexes, clonus, and contractures.

SYMPTOMS.—Spastic spinal paralysis is always of gradual onset. It may begin as a stiffness in walking or in using the arms which gradually increases and suggests a condition of tonic spasm. The essential symptom is spastic contracture of the muscles of the extremities, particularly the flexors.

The symptoms are most objectively conspicuous in the lower limbs, and the gait almost pathognomonic, consisting of short, jerky, spasmodic, dragging steps, the patient being tilted forward on tip-toe. The act of walking will sometimes induce a clonus causing a series of heel-taps as the foot drags along the floor. Clonus is nearly always present in decided degree, and the deep reflexes—knee, wrist, ankle, elbow, and jaw—are invariably greatly exaggerated. There are no sensory or trophic symptoms, nor are the intracranial nerves or functions involved; but the bladder is often disturbed, the patient exhibiting what Seguin has termed "hasty micturition." Sexual function may be indirectly lost.

In an examination of 35 cases of spastic paralysis, the writer found both Babinski's and Bechterew's reflexes present in 57.1 per cent., Babinski's alone in 25.7 per cent., Bechterew's alone in 11.4 per cent., and both reflexes absent in 5.7 per cent. In 17 cases in which both reflexes were present, Bechterew's was present on one side only in 6. The cases in which Bechterew's reflex was positive, in spite of the absence of Babinski's, are of special interest. Nikitin (Berl. klin. Woch., Sept. 7, 1908).

Spastic paralysis may result from an apparent normal delivery. In some cases interference with the dressing or the bathing of the infant may be the first evidence of an existing spas-

tic paralysis. In other cases delayed functions of sitting and walking suggest it. Convulsions in infants, either immediately after or shortly after delivery, should make us suspicious of cerebral injury. The possibility of syphilis as the etiological factor must always be remembered. Where ophthalmoscopic examination reveals increased intracranial pressure, and where there is not a great amount of interference with the mentality of the patient, **subtemporal decompression**, as described by Sharpe, should be performed. In the other cases, and in the after-treatment of cases operated on, **massage, electricity, manipulation, supports, tenotomies, and muscle education** usually offer relief. J. Grossman (N. Y. Med. Jour., Mar. 11, 1916).

DIAGNOSIS.—In spite of the vagueness of the pathology, the clinical picture is very constant and striking. Secondary lateral sclerosis from intracranial or basilar lesions is confusing only when such lesions are bilateral, and the presence in such cases of cranial-nerve involvement and of mental impairment will at once exclude the primary type. In myelitis with spastic contractures, the presence, in addition, of sensory symptoms, atrophy, rectal and vesical paralysis, with bed-sores and other trophic lesions, will readily differentiate. In disseminated sclerosis the patient may exhibit a typical spastic gait, with contractures and exaggerated reflexes, but the additional symptoms of intention tremor, nystagmus, scanning speech, oculomotor palsies, and sensory disturbances are peculiar, in their associated presence, to multiple sclerosis alone. In amyotrophic lateral sclerosis the marked and early atrophy is a distinguishing symptom. In progressive spastic ataxia, or ataxic paraplegia, the inco-

ordination is sufficient to exclude the disease under consideration. In all instances, primary lateral sclerosis should be diagnosed only after most rigid exclusion of every other possibility, and particularly disseminated sclerosis in an anomalous or atypical form.

ETIOLOGY.—The disease affects adult males chiefly, usually in the decade between 25 and 35. It is not very common, and its etiology is not at all definitely known. It occurs at times in several members of a family and in such instances doubtless is due to an embryonal defect.

PATHOLOGY.—The pathological evidence in support of the assumption that a primary sclerosis of the lateral columns exists is so slight and indefinite as to have led to much skepticism. Morbid changes found *post mortem* have been strikingly inconstant. Tumor, hydromyelia, pachymeningitis, transverse myelitis, syringomyelitis, hydrocephalus, and several times disseminated sclerosis are among the many lesions which have been observed.

• Hip-joint disease in 2 cases of congenital spastic paralysis. The special feature of the microscopic findings in both cases was the primary developmental defect in the cells of the motor zone in the brain, a hypoplasia of the ganglion cells. The pyramidal tracts were apparently intact in the second case. S. Miura (Jahrb. f. Kinderheilk., July, 1912).

PROGNOSIS.—The disease may last many years, the general health remaining quite good. Recoveries are unknown. The victim of the disease is sooner or later incapacitated for any and all forms of physical labor, though he may be able to employ the hands and arms after walk-

ing shall have become impossible. The mind is not affected.

TREATMENT.—Prolonged rest is of the first importance, and will at times result in decided amelioration of symptoms. The motor depressants—**hyoscine**, **atropine**, and **coni-um**—have all been successfully employed for the temporary relief of the spasticity. **Hydrotherapy** also serves effectually the same purpose.

Trial of **thiosinamine sodium salicylate** in a case of chronic sclerosis of several years' standing. The contractures and pain were much diminished, there was less ataxia, and the power of walking returned. The injections must be made deeply under the skin. K. A. Grossmann (The Hospital, Dec. 5, 1908).

Very severe and progressive case of spastic spinal paralysis in which there was no obtainable evidence of acquired syphilis. Patient was almost absolutely helpless and bedridden, and had been treated by almost every method known. When seen, in July, 1911, he was put on ascending doses of **potassium iodide**, which were rapidly raised to the overwhelming dose of 1248 grains (83 Gm.) in a single day. From this time the drug was continued in amounts of 375 grains (25 Gm.) three times daily, after which it was gradually reduced as improvement continued. To this treatment there were added **massage**, **passive movements**, **educational exercises**, and **forcible breaking of adhesions** in the joints. On January 1, 1914, the patient was discharged entirely cured. C. L. Nichols (L. I. Med. Jour., Oct., 1914).

Surgical measures have been resorted to for the relief of spasticity with considerable success. In **resection of the spinal roots**, first proposed in 1905 in this country by **Spiller**, the technique devised by **Förster** is that most employed at the

present time. The spastic contractures are either mitigated or cured, but adjuvant measures are indispensable.

Fifteen cases on record in which **resection of the nerve-roots** has been attempted, according to **Förster's technique**. Two of the patients died, both adults, one from infection and the other from operative shock. The other patients were remarkably benefited, being restored to active life after years of absolute and hopeless immobility. F. Rose (Semaine méd., July 7, 1909).

Förster's operation consists in division of the posterior spinal roots for severe forms of spastic weakness, especially in cases of cerebral diplegia, old hemiplegias, etc. The principle of the operation depends upon the fact that the spasticity is due to loss of inhibitory control from the higher centers. The operation consists essentially in the division of the paths to the affected groups of muscle, without producing either ataxia or anesthesia. It has been proven that anesthesia does not occur unless three consecutive posterior roots are divided; Förster recommends therefore that no more than two should ever be divided. The selection of the roots depends upon careful anatomical study. The indications for the operation are: (1) The presence of such severe contracture as to make standing and walking impossible. (2) The occurrence of painful cramps in the affected limbs. Thus far better results have been obtained for affections of the lower extremity than for the upper. The operation is preferably done in two stages. At the first a laminectomy with proper exposure of the dura is done. At the second the dura is opened and the affected posterior roots are resected. The after-treatment is important and includes correction of deformity by **mechanical means**, **plastic operations** to overcome organic contractures and **exercises**. Otto May (Lancet, June 3, 1911).

Fourteen cases of spastic paralysis treated by section of posterior spinal nerve-roots, 12 of them of Little's disease, while 11 were in the dorso-lumbar region. There were 2 deaths, the remaining 12 patients being more or less improved. There was cessation of spasm in all cases immediately after operation. Hunkin (*Am. Jour. Orthop. Surg.*, Oct., 1913).

Unilateral laminectomy, introduced by A. S. Taylor, seems to afford greater room for the surgical treatment of all degenerated cord lesions.

The severity of surgical resection of the spinal roots has led to the employment of other surgical measures of a more conservative type.

Transplantation of the muscles and tendons often proves surprisingly effectual. In the moderately serious cases improvement under operative and orthopedic measures is always notable. Redard (*Annales de méd. et chir. infantiles*, Oct. 1, 1913).

Three cases in which **Stoffel's method** of weakening the contracted muscle by severing certain of its nerve-fibers was tried. Balance between the muscle and its antagonist is restored. The patients were 3 and 12 years old, with Little's disease or paralysis from early encephalitis. In two of the children the results are highly satisfactory. Bundschuh (*Beit. z. klin. Chir.*, Sept., 1913).

Stoffel corrects talipes equinus by resecting a portion of the popliteal nerve. The electrode is used in distinguishing the nerve bundles. For contracture of the hamstring muscles, he operates upon the sciatic nerve in the upper thigh. For adductor spasm one or both branches of the obturator nerve are excised. In the upper extremity the median nerve is exposed at the elbow and the branch to the pronator teres and various flexor muscles resected as desired. The author reports 5 cases operated upon by this method. In some a second operation was performed, where too little of the nerve supply had been

resected. In the lower extremity the results seemed uniformly successful, but resections of the median nerve did not produce as good functional results, although the cosmetic results were satisfactory. The author also proposes, instead of **partial nerve resection**, a **transplantation of the same nerves** into the weak opposing muscles. Sharpe's **cerebral decompression** for spastic paralysis is on trial, but would appear to be of value only in recent cases in the newborn. Gill (*Ann. of Surg.*, 67, 529, 1918).

LANDRY'S PARALYSIS.

SYNONYM.—Acute ascending paralysis.

DEFINITION.—Landry's paralysis is a rapidly progressive motor paralysis of flaccid type, beginning in the extremities, usually the legs, extending thence upward through the trunk to the arms, and frequently to the nerves which have their origin in the lower pons-medulla region. In some instances the disease may begin above and progressively descend.

SYMPTOMS.—The disease begins with a feeling of extreme weakness, occasionally associated with paresthesia, especially numbness, in the legs. This is progressive, and in a few days or even hours there is complete motor paralysis of the lower limbs. Quite often the onset is attended with slight or, it may be in rare instances, decided elevation of temperature. Paralysis of the trunk-muscles follows, the sphincters escaping; and finally the muscles of respiration and deglutition are involved, such involvement usually terminating the disease fatally. This order of invasion and progress is, in rare instances, reversed. The motor cranial nerves have been said to have been affected in one or two reported examples of the disease. Minor sen-

sory changes, particularly hyperalgesia or anesthesia, are not uncommon, though rarely conspicuous. The deep reflexes always, the superficial reflexes occasionally, are abolished. The mental faculties are, as a rule, normal, though a muttering semidelirium is sometimes observed. Bedsores or other trophic symptoms are rare accidents, though atrophy of the muscles with altered electrical reactions may appear in protracted cases. In the typical disease the cycle is completed in from ten to fifteen days.

Many of the cases which have served to confuse the pathology of Landry's paralysis are only cases of acute poliomyelitis, in which the spinal cords, could they be examined, would reveal lesions of a distinctly inflammatory character, presenting quite a different pathological picture from that in which Landry was unable to demonstrate any definite changes. C. W. Hitchcock (Jour. Amer. Med. Assoc., Dec. 23, 1911).

Landry's paralysis is a clinical entity with varying pathological changes. These may be primarily in the peripheral nerves, and confined to them, or they may be myelitic only, and again neurocellular. **Poliomyelitis** is a pathological entity with varying symptom complexes. There may be flaccid paralyses, with muscle atrophy, or spastic paralysis, or cranial-nerve involvement, also ataxias and tremors or mixed types. Neustaedter (Med. Rec., Sept. 11, 1915).

DIAGNOSIS.—The diagnosis is quite free from difficulties, as a rule, if the doctrine of an identity with multiple neuritis be accepted. *Per contra*, the rejection of this theory renders the diagnosis between the two often a very complex problem. From fulminant forms of transverse myelitis it is to be distinguished by the involvement of bladder and rec-

tum and the more decided sensory disturbances in the latter affection. In myelitis, too, the deep reflexes are often exaggerated, there is the cincture symptom, trophic symptoms are of early onset and vicious progress, and the duration of acute myelitis is more protracted. The acute vascular lesions of the cord—particularly hemorrhage, if properly localized—may closely simulate symptomatically the disease under discussion. The history of trauma, the apoplectic onset, often with convulsions, and the rapidly fatal termination are data of value. Lumbar puncture with bacteriological examination of the serum should be a routine procedure. Quite possibly, too, intraspinal medication may prove effective.

Landry's ascending paralysis can be distinguished readily from polyneuritis and poliomyelitis by the absence in long-continued cases of muscular atrophies, reactions of degeneration, and sensory symptoms of paralysis. The typical cases depend on intoxication. The toxin seems to leave the sensitive neurone intact and to affect exclusively the motor function without impairing the structure. Bolten (Berl. klin. Woch., Jan. 16, 1911).

ETIOLOGY.—It is a disease of early or middle adult life affecting males chiefly. It is not very common. The etiology is not clearly understood, but there is a growing unanimity of opinion to the effect that the disease is due to a toxic infection. It may follow the infectious fevers. In at least one case seen by the writer, which terminated fatally on the eleventh day, gross alcoholism was the cause. Neither climate, season, nor heredity is an etiological factor.

Case of Landry's paralysis in a man, 46 years of age, indicating low-

ered resistance as the preliminary necessity in the development of the disease, with psychic depression. While no specific organism was likely to be proved the cause of Landry's paralysis, it seemed that some condition of toxicity springing out of unwonted virulence of some one of the bacterial flora native to the body and operating under the auspices of lowered resistance would be settled upon as the cause of this insidious, creeping death. E. M. Hummel (*N. Y. Med. Jour.*, May 31, 1913).

PATHOLOGY.—The pathology is as yet an unsolved problem, though the solution seems happily not far distant. Autopsies are often negative. Inconstant and widely varying lesions were reported or no determinable lesions whatever could be found, the latter result being the rule until within recent years. The theory of a profound and fulminant molecular disorganization of the anterior-horn motor cell is not plausible. That of an identity with poliomyelitis, differing in the acuteness and severity of form only, has been entertained and is based upon much quasisupportive evidence. That the disease is a pure form of fulminant myelitis is no longer accepted, although it is admitted that the resultant symptom-picture may closely simulate Landry's paralysis. The consensus of present-day neurological belief is that the disease is quite probably a special form of multiple neuritis affecting the lower motor neurons, with secondary changes in the anterior horns and muscles resembling or identical with those observed in poliomyelitis.

In the case studied by the writer, the pathological findings were those of an interstitial neuritis, affecting the nerve-roots and peripheral nerve-stems. In spite of this, no sensory

symptoms or pain on pressure occurred. The motor cells were well preserved, and the cellular changes which were present could hardly be regarded as having any direct relation to the paralysis. Pfeiffer (*Brain*, May, 1913).

In a typical case in a 16-year-old girl, with complete absence of fever, ascending flaccid palsy, causing death by finally involving the medulla, autopsy showed no naked-eye alterations in the brain and cord. The latter to the microscope showed severe recent lesions in the ganglion cells; more or less complete plasmolysis and chromolysis of the cells of the anterior horns. There were no inflammatory changes and nowhere any infiltrative interstitial process—which distinguishes this form of paralysis from the epidemic infantile type. The writer was able to inoculate apes with the disease, and to transmit it from ape to ape. The virus is filtrable and the period of incubation varies from seven to twenty-three days. Leschke (*Berl. klin. Woch.*, Apr. 27, 1914).

PROGNOSIS.—The prognosis is grave always; nevertheless, occasional recoveries have been reported. Should the disease not terminate fatally within 2 or 3 weeks the patient will probably recover. In those who recover there is no residual paralysis, the functions of the affected nerves being usually restored to the normal. A special susceptibility to subsequent attack is said to remain, but this lacks verification. The danger to life is, of course, greater when the heart and respiration are affected (bulbar extrusion or "bulbous type"); but even in such cases recoveries are said to have occurred.

TREATMENT.—This is empirical. The patient should be put to bed at once and kept **absolutely quiet**. The limbs should be enveloped in lambs'

wool fleeces or the hot wet pack. **Ergot** in $\frac{1}{2}$ - or 1-dram (2 or 4 Gm.) doses every 4 hours has been employed. **Quinine** in full doses with or without **sodium salicylate** may be used. Small and frequently repeated doses of **mercury** or **inunctions of mercury** are indicated. In plethoric subjects moderate **venesection** followed by **warm saline transfusion** suggests itself as a rational procedure. **Serum-therapy** may prove an aid ultimately. For the late stages of the protracted disease **potassium iodide**, **strychnine**, and **electricity** are indicated. **Oxygen** has been employed with symptomatic relief in the dyspnea from respiratory involvement.

The bladder, if involved, must be most carefully irrigated and **hexamethylenamine** given if urinary infection threatens. In their own case, in which the patient recovered, the writers gave **sodium salicylate**, which was followed by **potassium iodide** and **mercurial inunction**, in spite of the absence of syphilis. Later, large doses of **strychnine** were given, with the **faradic current** and **massage** to the paralyzed muscles. Three-dram (12 Gm.) doses of **fluidextract of cascara** were needed in the early stages, while later $\frac{1}{2}$ -dram (2 Gm.) doses sufficed. Hall and Hopkins (Jour. Amer. Med. Assoc., Jan. 12, 1907).

Typical case which improved under treatment with **galvanism**, **hot and cold applications to the spine**, and small doses of **ergot**, and was discharged, walking well, early in July, 1905, after a stay of eighty-two days in the hospital. He had a slight relapse, possibly hysterical, in October. This lasted less than a week, and he has been perfectly well ever since. J. K. Mitchell (Jour. Amer. Med. Assoc., Feb. 1, 1908).

Case presenting most of the symptomatic manifestations of Landry's paralysis, in which hypodermic injec-

tions of **strychnine sulphate** in full doses gave unexpectedly good results. Two subcutaneous injections of 0.005 Gm. ($\frac{1}{12}$ grain) each were given on twelve successive days, with the result that paralysis in the palate, facial muscles, and limbs—especially the upper extremities—disappeared with considerable rapidity. Pic, Bonnamour, and Blanc-Perduet (Lyon méd., Jan. 26, 1913).

HEREDITARY ATAXIA.

SYNONYMS.—Friedreich's ataxia, or disease; family ataxia.

DEFINITION.—It is a distinctly, though not necessarily a directly, hereditary degenerative disease of the spinal cord, affecting the posterior and lateral columns and the bulbar region, usually beginning in childhood, with symptoms of ataxia, curvature of the spine, defects of speech, talipes, choreiform movements, vertigo, and ultimately paraplegia.

SYMPTOMS.—In very young children the initial symptoms may not be recognized, but may be interpreted simply as indications of slow development or unusual awkwardness. The child stumbles and falls easily or staggers in attempting to stand or walk. The hands are used clumsily and coordination appears to be learned with unusual difficulty. In speaking, the child draws its words. The development of nystagmus, of curvature, or of talipes in some form may prove the first obvious and unmistakable evidence of the affection. The disease is much more readily recognized when the symptoms develop later in life, as at 8 or 10 years of age. Contrast with a previously normal standard renders it conspicuous.

The gradually or rapidly increasing ataxia of gait and station; the choreiform ataxia in using the hands; the

slow, drawling, thickened or scanning speech; the nystagmus; the club-foot; the hammer toe; the curvature of the spine, and the paraplegia are pathognomonic when conjointly associated in early life in two or more members of the same family. Weakness in the legs is present early with the ataxia, and ends in a paraplegia. Sensory symptoms are rare, though, subjectively, headache and slight aching or pains in the limbs may be present. Vertigo is not uncommon. The sphincters are not involved until late in the disease. The knee-jerks are lost, as a rule. Atrophy of muscles and trophic lesions of the skin are exceedingly uncommon except late in the advanced disease. The electrical reactions are usually undisturbed. In a very few cases paresis of the eye-muscles has been noted. Usually some degree of impairment mentally is present.

The sensory disturbances found in 20 typical cases of Friedreich's disease were as follows: The appreciation of touch, pain and temperature were very irregularly affected in the upper extremities, never more than very slightly and often not at all. When loss occurred it was almost always a slight distal blunting to touch, and very rarely to pinprick, or to heat and cold as well. In the lower extremities these cutaneous elements were more frequently involved, and there was often some distal hypoaesthesia. Appreciation of simultaneous contacts, and of size, shape, and form, was most severely affected. Saunders (Brain, Nov., 1913).

DIAGNOSIS.—There are only two diseases which are likely to confuse the diagnosis: *disseminated sclerosis* and *Huntington's chorea*. In the latter the disease occurs in middle life or later, as a rule; the mental facul-

ties are more markedly involved; the choreiform movements are far more active and extreme; the speech is jerky or explosive; and there is no curvature, no talipes, and usually no nystagmus. From *multiple sclerosis* the distinction is sometimes impossible. The family history as to direct heredity is of value, but the fact that a brother or sister is similarly affected is less valuable since Dreschfeld and others have reported multiple sclerosis in two members of the same family. The cranial nerves are more frequently affected in disseminated sclerosis; the knee-jerks are often exaggerated; disturbances of sensation are much more common, which is true also of sphincteric involvement. The tremor when present in Friedreich's ataxia is less of the intention type and more like that of chorea. Convulsions and crises point to multiple sclerosis. Remissions do not occur in the latter, while not uncommon in the former.

Tabes in young people as the result of a general hereditary syphilitic taint is often confounded with Friedreich's ataxia. **Tumor of the cerebellum** is accompanied by pain, vomiting, and optic neuritis. In **ataxic paraplegia** the knee-jerk is increased, the onset is later in life, and there is no hereditary tendency. Griffith (Brit. Med. Jour., Mar. 9, 1907).

ETIOLOGY.—The essential predisposing factor is an inherent developmental defect of the spinal cord, especially the posterointernal and lateral columns. The heredity is sometimes direct, but more frequently indirect. Organic insanity, gross alcoholism, syphilis, consanguinity of marriage, epilepsy, or some other degenerative neurosis may constitute

the ancestral or parental taint. A generation may be skipped, the parents being apparently healthy. Tabes is rare in the family history of this disease. Direct inheritance of the disease itself was found by Griffith in 33 out of 143 cases. It is somewhat more frequent in males than females (86 males, 57 females—Griffith's table) and more than two-thirds of all cases develop symptomatically within the first decade of life (99 out of a total of 143—same author).

The disease seems to be more common in America than elsewhere, and the victims are from the rural districts rather than the cities. It is the rule to find more than one case in a family, and sometimes several brothers and sisters may be affected in succession. Three of the writer's cases were in brothers and sisters, the mother of whom was undeveloped, both physically and mentally, almost a midget in physique and with low mentality. The first obtrusive symptoms may follow an acute illness, especially the infectious fevers.

Five cases of Friedreich's ataxia occurring in two families. In one family two sisters, aged respectively 17 and 10 years, were affected, and in the other family the second, third and seventh members of a family of thirteen were affected. These 3 patients were two brothers, aged respectively 29 and 18 years, and a sister, aged 27 years. T. W. Griffith (Brit. Med. Jour., Mar. 9, 1907).

PATHOLOGY.—The gross pathological anatomy has been quite satisfactorily demonstrated. The extent of the lesions may vary, however, considerably. The cord appears diminished in bulk and sometimes of eccentric contour macroscopically. Occasionally two central canals have

been found or the one central canal may be disproportionately large. Various other developmental anomalies may be present. The morbid process is that of sclerosis, which is always well marked in the lateral pyramidal and posterointernal columns, but may also involve the columns of Türek and the direct cerebellar tract. It does not invade the gray matter, which is usually separated from the diseased columns by a layer of healthy tissue. Dejerine believes the sclerosis found in family ataxia to be really a neuroglial sclerosis or form of so-called gliosis, due to a developmental ectodermal defect. The columns of Goll and the pyramidal tracts are affected in varying degree throughout their entire course. The pathogenesis is as yet undetermined.

PROGNOSIS.—The duration of the disease is indefinite. Death may occur from a bedridden asthenia, but is usually due to some intercurrent affection. The disease may be complicated with insanity.

TREATMENT.—There is little to be done for these patients. **Suspension** has been tried, largely in vain. **Arsenic** is at times beneficial. The **Fränkel method** is indicated for the ataxia. Prevention of the disease by means of careful selection in marriage, or, better still, **celibacy** among the tainted, is much the more hopeful and legitimate line of action. Should the disease appear in the first child, further pregnancies or births should be prevented. The idea of preventing the development of the disease by withdrawing the infant from the mother's breast, as has been suggested, seems far-fetched.

Cases of hereditary ataxia are not necessarily doomed to chronic in-

validism. The writer's patient, an adult male, 44 years of age, traced his illness back to the sixth year of life, lived comfortably with the aid of **selected occupation**. The patient could plow, drive, and do most of the lighter work about the farm. When 30 years of age he became so disabled that he had to use crutches, and he then became a schoolteacher, following this occupation until two years ago, when the increasing ataxia in his hands compelled him to abandon this work also. His general condition remained good. Van Wart (N. Y. Med. Jour., Dec. 31, 1904).

ATAXIC PARAPLEGIA.

SYNONYMS.—Progressive spastic ataxia; combined posterolateral sclerosis.

DEFINITION.—As described by Gowers, it is a combination clinically of ataxia and spastic paraplegia, having an anatomical basis in lesion of the dorsal and lateral columns. The disease is probably not a distinct pathological entity.

SYMPTOMS.—The clinical picture is usually clear-cut and constant. The first symptom is ordinarily that of constant fatigue, with more or less unsteadiness in standing or walking. This ataxia is especially marked in the dark or with the eyes closed. The sphincters may be affected at the same time and sexual power lost or impaired. There are no sensory symptoms except, perhaps, a subjective aching in the legs and lumbar region. Paretic weakness in the legs, particularly the flexors, gradually and progressively develops. One leg may be more affected than the other at first. More or less rigidity, with exaggerated knee-jerks, clonus, and contractures, develop. The patient becomes more and more dependent upon assistance in walking, spread-

ing the feet wide apart with eyes fixed upon the floor. The feet are dragged along, however, and not brought down with unnecessary force as in true tabes. The cranial nerves are rarely involved, but the mind undergoes degenerative deterioration, often like that of general paresis. The arms may, like the legs, show spastic paralysis and inco-ordination. Trophic symptoms are absent.

DIAGNOSIS.—The total absence of pupillary changes, of sensory symptoms, and of Westphal's symptom excludes true tabes readily. The spasticity and exaggerated reflexes with clonus may suggest primary lateral sclerosis, but there is no ataxia in the latter affection. Ataxia and parapareses, with exaggerated knee-jerks, may be present in disseminated sclerosis, but there will be, in addition, involvement of the cranial nerves, intention tremor, scanning speech, nystagmus, etc. Tumor involving the cerebellum may induce symptoms of inco-ordination and spastic paralysis; but here, again, the addition of cranial-nerve symptoms, especially of the optic nerve, will clear away any temporary confusion.

ETIOLOGY.—As with most of the degenerative spinal sclerosis, ataxic paraplegia is most common in males during middle life, and the causes are also similar. Gowers, Osler, and others deny the relationship of syphilis as a cause except in rare instances: this is disputed by most observers. Lead and other poisons may superinduce the disease. Heredity is a minor factor, if it exists at all.

Under this group might be included the so-called Putnam-Dana variety of myelitic sclerosis of hematogenous origin, though in the latter

the age of incidence and the marked preponderance of females are quite distinctive. (See also PERNICIOUS ANEMIA.)

PATHOLOGY.—As they are described by Gowers, the lesions consist of sclerosis of the posterior and lateral columns, which is very variable in extent and position and not strictly "systemic" in character, the mixed zone of the lateral and the lateral limiting layer between the pyramidal fibers and the gray matter being involved quite often. In the posterior columns the sclerosis is frequently more marked in the dorsal than in the lumbar segments. Occasionally a zone of sclerosis has been found in the entire periphery of the cord (annular sclerosis). Türk's columns may be affected. Marie does not consider it a systemic disease. He believes the distribution of the sclerosis to be dependent upon the arterial supply through the branches of the dorsal spinal artery, which are involved. By many the disease is believed to be a form of chronic mid-dorsal myelitis, by others simply an atypical form of tabes, and by others still an atypical variety of multiple sclerosis.

That ataxic paraplegia is identical with general ascending paresis has been maintained. The final decision, however, is still *sub judice*.

PROGNOSIS.—Except in the syphilitic cases, the prognosis is bad. The duration is extremely variable. Often many years elapse before the victim succumbs. Paralytic helplessness may develop, however, within a few years and become complete. When mental symptoms are manifest early, the prognosis is that much worse.

TREATMENT.—Potassium iodide should be invariably tried. The patient is thus given the benefit of the possibility that syphilis may be the cause.

SYRINGOMYELIA.

DEFINITION.—The term etymologically signifies a cavity (abnormal) in the cord. This definition is, however, misleading. By almost general consent the word has been restricted in its application to a disease characterized anatomically by lesion usually and chiefly of the central substance of the cord; pathologically by a gliosis or gliomatosis often dependent upon embryonal-tissue persistence, with subsequent perverted cellular proliferation and ultimate cavity-formation; clinically by the presence, in association, of progressive muscular atrophy, dissociation of sensation, prominent trophic symptoms, and scoliosis.

SYMPTOMS.—The clinical picture is very variable. There is not a function of the cord which may not be perverted, and, on the other hand, no disturbance at all may be present or at least recognized. There is no single pathognomonic symptom, nor any constant grouping of symptoms.

Case of a patient, 17 years old, who presented evidences of loss or reduction of sensibility to pain and heat in various regions, incipient atrophy of certain muscles of the hands, and left scoliosis. The course of the case confirmed the presumptive diagnosis of syringomyelia. The writer has observed left scoliosis also in 2 other cases as an early symptom. Lifshitz (Roussky Vrach, iii, No. 13, 1905).

The cavity may be so small as to give rise to but few symptoms, but by extension may compress or destroy the posterior columns, poste-

rior gray horns, and even the crossed pyramidal tracts. Then, again, it may be of various irregular shapes, thus giving rise to most irregular symptom complexes. E. P. Bernstein and S. Horwitt (*Med. Rec.*, Oct. 18, 1913).

In the cases in which the diagnosis has been made during life and confirmed by autopsy the clinical history has been about as follows: The patient first notices some aching and pain in the neck, shoulders, and arms, with paresthesia in the hands and fingers. This is followed by an atrophy which slowly affects, first, the smaller muscles of the fingers and hand, and which is attended with fibrillary twitches. Analgesia develops in varying degree in the affected limb, and thermoanesthesia, sometimes complete, is also present. Tactile perception may remain either normal or only slightly impaired, and this combination of analgesia with thermoanesthesia and preserved tactile perception constitutes the so-called "dissociation phenomenon" at one time supposed pathognomonic.

Following the atrophy and sensory disturbances, trophic lesions of the skin, hair, nails, bones, etc., develop, and are often quite prominent. Herpes, bullæ, ulcers, felons, and gangrene, usually painless, are among the skin lesions observed. Extensive arthropathies have been noted, and the bones may become quite brittle.

Two cases of the sacrolumbar type occurring in a brother and sister. The bones show a peculiarity which is described by Tedesco: (1) a general transparency of the bone-shadows as a whole; (2) diminution and softening of the cortical layer of the diaphyses; and (3) rarefaction of the spongy bone while its external form is preserved. When the process of atrophy is far advanced, however, the

bone gradually disappears, as the skiagrams show. The accompanying increased brittleness accounts for the occurrence of fractures. Spontaneous fractures, however, do not occur as frequently as one would expect. J. M. Clarke and E. W. H. Groves (*Brit. Med. Jour.*, Sept. 18, 1909).

Vasomotor symptoms—such as sweating, edema, redness, or cyanotic discoloration in certain areas or a limb—are quite common. As the disease extends from above downward, the trunk-muscles become involved, and scoliosis, or curvature, develops. Extending still lower, the legs are affected with paraplegic weakness, the sphincters become paralyzed, and sexual power is lost. Just as with the upper, the first symptoms indicating involvement of the lower cord may be irritative—paresthesia may precede the paraplegia. Should the disease extend upward, bulbar symptoms are added. The trigeminus may be affected and facial atrophy appear. Pupillary abnormalities have been noted occasionally, particularly an inequality in size and response. The eyeball may appear protuberant as in exophthalmic goiter, or the globe may appear to have receded. This condition is often associated with facial hemiatrophy (Schulte). Ataxia of both lower and upper extremities has been observed. The muscular sense, however, may remain normal.

Case of paralysis in the throat and palate, with sensibility and reflexes normal, in which further investigation revealed syringomyelia. There had been no other noticeable disturbances, but atrophy of the right side of the tongue confirmed the diagnosis. The writer found 26 similar cases. Throat symptoms may be the first sign of the affection. In 9 of the 27 cases there was atrophy of the

tongue, and there was paresis of the palate in 17. In 3 cases the hoarseness came on suddenly. Baumgarten (Berl. klin. Woch., Aug. 23, 1909).

The symptoms are usually bilateral, though they may at first and for some time be limited to one side, and they are often unequal in degree on the two sides. The first symptom may be referable to the dorsolumbar or the bulbar segments, in which case, of course, the order of sequence would be reversed. This is the basis for the so-called bulbar and paraplegic types.

Case in which the disease began at the age of 5; the patient is now 16. Pain in the back of the head and the curving of the spine were together the earliest signs. (One of Guillain's cases which went to autopsy commenced with the same pain.) These disappeared in the girl's case. Gradually at the age of 6 the left arm began to be affected. The lower extremities were attacked at about 10 years of age, and the right arm has only shown involvement for three years. For the last year there has been slight difficulty in micturition, frequency being increased. G. W. Howland (Can. Pract. and Rev., Aug., 1909).

In certain cases trophic symptoms predominate, due, it has been thought, to a complicating neuritis. Morvan's disease is assumed by many to be essentially identical with this form of syringomyelia. The identity has not yet been proved.

Case of Morvan's type of syringomyelia in a lad aged 17 years. A marked stoop, due to weakness of shoulder and back muscles, a well-developed scoliosis to the left, arms abnormal, right hand and arm atrophied, with loss of muscular power. The left hand had lost the distal phalanges from thumb and first and second fingers, was reddish, swollen,

and slightly edematous; shoulder-muscles paralyzed on left side, and the limb practically useless; no dissociation of sensation, but complete anesthesia over an area beginning from a line passing between the mastoid processes behind and from the notch in the thyroid cartilage to the mastoid processes in front, down to a line passing from the level of the third rib, in front, to the sixth dorsal spine, and including both arms. H. V. Wildman, Jr. (Med. Rec., Oct. 17, 1914).

DIAGNOSIS.—With our present knowledge, or rather lack of it, an inaccurate diagnosis in syringomyelia is not a serious reflection upon individual skill. In the differential diagnosis of the disease, tumor and hemorrhage of the cord, myelitis, pachymeningitis, particularly cervical hypertrophica, progressive muscular atrophy, and tabes dorsalis are chief in importance.

Case of tabes with syringomyelia. Some have held that the association of the two processes is not merely a coincidence, but that one stands to the other in the relation of cause and effect; others have expressed themselves guardedly. Spiller (Jour. Med. Research, Mar., 1908).

In tumor all irritative symptoms—such as pain, spasm, etc.—are usually far more pronounced, the symptoms are more definitely localized and unilateral, and the rate of progress is more rapid. Tumor elsewhere, especially if malignant, is significant. In cord hemorrhage or embolism the onset is abrupt and apoplectic in nature and the symptoms are rapidly destructive. From myelitis the diagnosis may be, at times, difficult. The more widely distributed symptoms and the more extensive involvement of all forms of sensation, with the relative infrequency of true trophic

symptoms in myelitis, should prove sufficient data.

The muscular atrophy is often late in myelitis and is more rapid after once beginning. From cervical pachymeningitis the differential diagnosis is at times impossible during life. It is only when *tabes dorsalis* begins with extensive and vicious trophic symptoms or when it presents the symptom of dissociated sensation that temporary hesitancy occurs. In leprosy we may have analgesia and trophic lesions, but there is no atrophy, scoliosis, or dissociated sensation.

Case of dislocation of the first row of phalanges on the metacarpals which proved to have been due to syringomyelia. This causes extensive trophic alterations in the upper extremities, as does *tabes dorsalis* in the lower limbs. The arthropathies which result bear a certain resemblance to arthritis deformans, the analgesia, however, contributing to aggravate the state of affairs. In the neuropathic arthropathies we usually see destruction of the articulating structures, but the dislocations may exceptionally occur without this prerequisite, especially in the shoulder-joints. Joachimsthal (Berl. klin. Woch., Aug. 12, 1912).

ETIOLOGY.—The disease is comparatively rare. More cases have been reported among males than females, in many instances recognized first between the ages of 25 and 35 years. The essential causative factor is an inherent predisposition dating back to embryonal life. Syringomyelia is not directly hereditary, nor is it a "family" disease. No adequate explanation is offered for the cause of the underlying developmental defect. The exciting cause is most often trauma.

Secondary infection is doubtless occasionally responsible. Prolonged exposure to severe cold and dampness, physical overexertion, toxemias, malnutrition, and anemia are causes to which individual cases have been ascribed. Alcoholism may act as an indirect etiological factor. The clinical association of syringomyelia with acromegaly suggests a fundamental teratological origin.

PATHOLOGY.—Cavities of the cord may exist as congenital doubling, diverticula, or other anomalies of the central canal, or they may be secondary to acute lesions, such as abscess, hemorrhage, tumor, etc. Simple dilatation, more or less extreme, of the normal canal may occur (*hydromyelia*), which often is unattended by any symptoms whatever.

In a personal case the pathological process completely isolated the posterior columns from the rest of the spinal cord from the first cervical to the eleventh thoracic segments, inclusive. There was perfect preservation of tactile sensibility and loss of pain and temperature sensibility. There was very diagrammatically demonstrated the lower limit of the trigeminal area. The cavity formation in the gliomatous tissue was most marked on the right side. The case shows that with total cutting off of all the afferent pathways of the cord with the exception of the posterior columns tactile sensation is quite unimpaired. A. R. Allen (Jour. Nerv. and Mental Dis., Jan., 1911).

In some instances hydromyelia gives rise to symptoms identical with syringomyelia, but the essential pathological basis of the latter disease is a slow central gliosis: In the embryo the central canal is relatively large. It closes by gradual approximation of its walls posteriorly, which, uniting,

form the normal posterior septum. The anterior walls remain separate, forming the normal central canal. Interruption or perversion of the normal development results in the formation of a cavity. Such interruption may be localized to one or more segments or extend for some distance.

The cell-elements remain of the embryonal or glia type. They are distributed irregularly in the cavity-walls, sometimes occurring as nests resting upon a basement material. These ependymal and periependymal cells and neuroglial or basement tissue, later in life, through the stimulus of trauma, infection or some other exciting cause, begin to undergo proliferation, forming gliomatous masses. The proliferation extends from center toward periphery and also longitudinally, usually in the posterior areas of the cord first. The most common locality affected is the cervical cord. This new gliomatous tissue, from low vitality, hemorrhage or other vascular lesion, breaks down and a cavity results.

Recent advances in the pathology of syringomyelia bear especially upon the hyperplasia of connective tissue associated with the gliosis. In a personal case, evident proliferation of connective tissue was present at all levels of the lesion; the blood-vessels throughout were very numerous with much thickened adventitia; curiously, there were also striated muscle-fibers in various spots between the fourth cervical and the eleventh dorsal segments. This was ascribed to defect in embryonic development. André-Thomas and Quercy (*Nouvelle Icon. de la Salpêtrière*, xxv, 5, 1913).

The gliosis may not always end in cavity-formation, but may remain as a tumor or as simple glia hyperplasia, which, however, destroys the normal

motor and sensory cell-bodies and their axis-cylinders quite as effectually as the breaking-down. The tendency to cavity-formation is said to be proportionate to the excess of cellular over basement tissue in the gliosis. Secondarily atrophy of the muscles and various forms of peripheral neuritis are among the pathological findings.

PROGNOSIS.—There is no cure for the disease; hence an unfavorable prognosis must be given as regards recovery. The disease may progress very slowly, however, and a duration of twenty or more years is said to be not uncommon. Spontaneous remissions may occur which may last through several years.

TREATMENT.—Gliomatosis of the cord is unamenable to curative or even palliative treatment. **Potassium iodide** has occasionally proved to be of service in gliomatous tumors of the brain and should be tried faithfully. **Silver nitrate, gold salts, arsenic, and iodine** are theoretically indicated. **Electricity** has been almost invariably disappointing, except as a tonic. **Change of climate, rest, and tonics** offer the best prospect for a temporary arrest of the disease.

Radium has been recommended by Raymond Touchard and other authorities. The applications were made daily to the vertebral column at various levels, alternating to the right or left of the spinous processes. The exposures were increased from 10 minutes to over one hour. **X-rays** have also been advocated.

The use of the **X-rays** entirely changes the clinical history of the disease, causes considerable improvement, which lasts for some time, and wholly changes the prognosis. E.

Beaujard and J. Lhermitte (Semaine méd., Apr. 24, 1907).

Details of a case of syringomyelia. In a workman of 51, the **Röntgen rays** arrested the morbid process and seemed to allow restitution of the functions of the nerve-tract involved. The effect is evidently due to direct local action on the pathological process in the spinal cord. There was restoration of the functions of the hands and fingers. The improvement has persisted to date, nearly two years, and the patient has gained over 25 pounds in weight. I. Holmgren and O. Wiman (Nordiskt Med. Arkiv, xli, Int. Med., No. 3, 1909).

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SPINAL CORD & NERVES, INJURIES AND SURGERY OF.

—The spinal column, as outer and protective covering of the spinal cord, being primarily injured in traumatism of this region, such as **gunshot** and **punctured wounds**, and **sprains** and **dislocations**, the lesions suffered by the cord proper are reviewed in the article on the SPINE, DISEASES AND INJURIES OF, which follows the present section. Lesions of the cord, which complicate fractures of the spinal column, are treated in the fourth volume in the article on FRACTURES AND DISLOCATIONS, page 759.

As regards operations on the spinal cord, **laminectomy**, which affords access to the cord, is also treated in the article on the SPINE, which follows the present one, while the operations on the spinal cord indicated in certain diseases of that organ, such as **resection of nerve-roots** in **primary lateral sclerosis**, are treated under the headings of these diseases in the article on SPINAL CORD, DISEASES OF, preceding the present section.

NERVES, INJURIES OF.

SUBCUTANEOUS NERVE INJURIES.—By these are meant injuries of nerve in which the skin has not been penetrated.

Contusion.—A blow on the elbow, a fall in which the subject alights violently

on his hands and other similar sources of violence to the surface may sufficiently jar a nerve-trunk, or, at least, its terminal fibers, to awaken functional disturbances; these are sometimes accompanied by severe pain and shock. As a rule, if there is no lesion of continuity of the medullary sheaths or of the axis-cylinders due to laceration of the perineural tissues, the disturbance awakened is transitory.

Contusion.—**Pressure paralysis**—contusion of a nerve—should mean the lesions that direct traumatism produces. As generally interpreted, however, it denotes the symptoms of pressure upon a nerve however awakened. "Pressure palsy" form is frequently experienced by everyone when, during sleep, for example, a limb is held in an abnormal position. Numbness is followed by tingling when the position of the limb is changed to normal. This temporary palsy is the mildest form of nerve "contusion." Surgical anesthesia is responsible, however, for paralyses which may last weeks when care is not taken to prevent a limb from hanging over the table, thus allowing its edge to exert pressure upon one or more nerves. An Esmarch bandage, too tightly or improperly applied, or left in place, may do likewise; indeed, permanent paralysis of the radial, ulnar and external popliteal have been provoked in this manner.

Nerves which pass over or are in close proximity to bones are most exposed to pressure, hence the frequent paralysis due to contusion of the sciatic when reductions of dislocations of the hip, especially those of the traumatic and congenital type, are attempted. Callus, produced in the course of bone repair after fractures, scar tissue, projecting bone, or spicules of the latter, osteoma, infiltration, etc., are as many causes of pressure paralysis which may be accompanied by, more or less, severe neuralgia.

Stretching and Laceration.—Stretching of a nerve sufficiently to produce laceration occurs in the course of accidents or operative procedures in which undue traction is exerted either directly upon a limb or through malposition of the bones in the course of dislocation, as, for instance, in shoulder dislocation. Laceration of nerves may complicate fractures of the

base of the skull and thus give rise to disturbances of vision, paralysis of one-half of the face, etc. In general, the symptoms of laceration are disturbances of sensation or motion, or of both these functions, sufficient to give rise to the reaction of degeneration.

Displacement.—Displacement of a nerve may occur when, as a result of excessive flexion of a limb, the groove over which the nerve passes fails to hold it in position. The ulnar, for instance, may be displaced by forcible flexion of the arm when the medial epicondyle is shallow. In some subjects such a displacement occurs whenever the forearm is flexed, without causing discomfort. Displacements of the ulnar and external popliteal may also occur in fractures of the medial epicondyle of the humerus and of the head of the fibula. Under these conditions, contusion and inflammation, with considerable pain, throughout the area of distribution of the nerve, and also sensory and motor disturbances may follow.

TREATMENT.—The treatment depends, of course, upon the nature of the condition present. In *uncomplicated contusions and lacerations* the measures should be conservative, **immobilization** of the part in a cast to prevent traction on the injured nerve. If the reaction of degeneration is present, **weak galvanism**, the cathode over the seat of injury and the anode on the plexus of the system enervating the part, should be begun **after the acute phenomena** have subsided. Resumption of function follows after from 4 to 6 weeks in simple cases.

When the injury involves the whole nerve transversely, as indicated by the failure to improve, operation should be resorted to as soon as possible, as time compromises the issue increasingly. Exposure of the nerve will then reveal some of the conditions described, *i.e.*, it will be compressed by or imbedded in a mass of scar tissue or callus. **Neurolysis** and, preferably, **Babcock's nerve dissociation** should then be resorted to. This procedure has for its purpose to relieve nerves of compression by adhesions, fibrous cicatricial tissue, callus, bone infiltration, etc., which give rise to painful or paralytic affections.

By the term **dissociation** the writer means isolation of the affected part of the nerve through an incision freely opening its sheath, disassociating its component fibers and isolating the nerve from later fibrous compression. It is intended to permit the escape of exudate from within the nerve-sheath, to reduce pressure upon individual nerve-fibers, to free axis-cylinders which have become useless through entanglement of severed tissue, to facilitate the formation of new nerve-paths, and to stimulate desirable changes in the nerve-trunk.

The sheath of the nerve is divided well beyond the limits of lesion; the nerve-trunk, lifted upon one or two fingers, is held taut. The nerve-fibers are then carefully separated from each other by means of a small sharp tenotome, transforming the structure from a round cord to a flat, ribbon-like band of separated fibers. If cicatricial tissue is encountered in the nerve-trunk the separation of the fibers is prolonged along straight lines, dividing the scar into multiple parallel threads of tissue. The nerve, previously imbedded in cicatricial or fibrous tissue, should be removed from this area, or at least isolated from future cicatricial adhesions by the interposition of adipose tissue, strips of which can usually be secured from beneath the skin.

Out of 7 cases in which the nerve-fibers had been partially or thoroughly dissociated by the writer, in only 1 was there detected an increase of paralysis immediately following the operation, while in several there was almost immediate increase of function in the affected nerve-field. Babcock (*Annals of Surg.*, Nov., 1907).

When compression is due to cicatricial tissue, the latter is exposed and the nerve isolated from it by dissection. The fibrous tissue is then removed, and the nerve surrounded with Cargile membrane to prevent invasion of surrounding tissues during the healing process. A bony cal-

lus may be reached, if necessary, through the muscular planes. The nerve is isolated and the bony mass removed, a procedure which sometimes requires the aid of the chisel. Here, again, Cargile membrane should be employed to protect the nerve during the healing process.

The nerve may be found severed and the intruding mass of callus or scar tissue prevent union of its ends. In that case, the nerve should be treated as described under the next heading.

OPEN NERVE INJURIES.—By these are meant injuries, whether exercised by cutting or pointed instruments, bullets, etc., in which the skin has been penetrated.

Effects of Nerve Division.—When a nerve has been severed its vasomotor functions cease; the vessels it supplies being thus allowed to dilate, more blood is admitted into the area to which the vessels are distributed. The temperature of this area is, therefore, raised. But this rise is only temporary; the continued vasodilatation due to loss of vasomotor control soon interferes with the *vis a tergo* motion of the blood and, the local circulation being slowed and poorly oxygenized, the parts become blue and cold, and lose their functional activity. Muscles lose their motor power at once, and soon begin to degenerate, atrophy and shorten, and finally develop the reactions of degeneration. If the nerve contains sensory fibers, complete anesthesia to pain, touch and temperature follows, unless the part be supplied by another nerve in addition to that severed. Yet, pressure with a blunt object may be felt in the analgesic area; this is because motor branches of a mixed nerve send sensory branches—deep sensibility nerves—throughout muscles and tendons, which may leave the nerve above the point of section.

The trophic changes which may arise in the paralyzed parts are numerous: the skin may be the seat of eruptions and ulcers, or become glossy; the hair falling out, the nails becoming furrowed, brittle and even shed; the deeper tissues may be the seat of painless felons or abscesses, or, as is the case with muscles, atrophy; the joints may become inflamed—a condition which may lead to ankylosis.

Finally, dry gangrene is a formidable complication which not infrequently follows division of large nerves.

The effects of abolition of the functions of the severed nerve continue until its regeneration occurs, if at all. The nearer the two ends of the severed nerve remain the greater are the chances of early union; hence the curative effects of nerve suture, in which these two ends are held in apposition. In the absence of suture, the abolition of function may be permanent. When, however, proximity of the two ends is such as to permit union, sensation may return in from 6 weeks to as many months. Motor power is slower to return than sensation, and takes from 3 months to 3 or 4 years, but seldom before 6 months. Anastomosis with adjacent nerves probably accounts for the exceptional cases in which very early resumption of sensation and motion has occurred.

Process of Repair.—After complete division of a nerve the entire peripheral or distal end degenerates. The proximal or body end, however, degenerates only in the portion immediately adjacent to the seat of injury, and tends rapidly to regenerate. This is accomplished through the formation, just above the site of injury, of an enlargement or bulb composed of imbedded and very small nerve-fibers. These new fibers infiltrate the granulations formed from the cells of the sheath of Schwann and project themselves until they reach the distal end of the nerve, which they penetrate to its terminal filaments, thus re-establishing function. According to some histologists incompletely developed elements are also formed in the distal segment of the cut nerve, which meet those from the proximal segment.

The central stump of a nerve long retains its capacity to sprout new fibers, and consequently it is of little moment when the nerve is sutured during the first 4 or 6 months after the injury. The prognosis depends more on the location and extent of the injury, the peripheral nerves having a greater proliferating power than those more centrally located. The general health is an important factor in the outcome. Spiel-

meyer (Münch. med. Woch., Jan. 19, 1915).

SYMPTOMS.—As we have seen, the symptoms following division of a nerve consist in loss of function, motor, vasomotor, and trophic. If complete section occurs the abolition of function is immediate; if it is incomplete, pain and paresthesia may appear.

The anatomical position of the wound governs, of course, the nature of the morbid phenomena awakened. After complete section these consist of absence of reflexes, flaccid paralysis, soon followed by muscular atrophy. If, for instance, one or more cords of the brachial plexus are severed, motor paralysis and anesthesia appear throughout the area supplied by the severed cord, whether this be through the ulnar, median, subscapular, circumflex or other nerves supplied by the plexus. These symptoms are the same as if the nerve itself had been severed. Thus, involving as it may do, the circumflex, we would have paralysis of the deltoid and, as a result, inability to raise the arm to a right angle with the body. If the outer cord of the brachial plexus is severed, the musculospiral nerve will be involved; we shall then have paralysis of the biceps and of the brachialis anticus, which means paralysis of the forearm flexors, etc. Yet we must not lose sight of the fact that this same cord of the brachial plexus gives origin to the external anterior thoracic and median, and that the resulting paralyses are added to those due to involvement of the musculospiral. The great multiplicity of nerves renders necessary an intimate knowledge of their distribution.

In so far as their surgical treatment is concerned, the measures indicated, as we shall see, apply to all nerves. When degeneration takes place in antagonistic muscles, these gradually contract, producing deformities.

The sensory disturbances are not as widespread, because the terminals of sensory nerves anastomose freely, as a rule, with those of adjacent nerves, while cutaneous sensory fields overlap one another. The tendency, moreover, is for the anastomotic branches to take up the work of the cut nerves. Hence, the rapid reduction of the area of sensory distur-

ances and the fact that it is only when large trunks, which give off many important nerves are cut, that extensive or permanent sensory disorders follow.

It is not only the muscular and cutaneous functions (the skin being subject to disorders such as eczema, herpes zoster, ulcers, etc.), that suffer, but likewise the bones. During growth the development of osseous tissue in the parts supplied by the severed nerve may cease, and atrophy even follow, the morbid process being aggravated by serous infusion of the joints. Vasomotor disturbances, such as redness, cyanosis, and cutaneous hypothermia have already been mentioned.

The reaction of both nerve and muscle to electricity should be determined when injury to a nerve is suspected. That of a divided nerve and of the muscles it supplies to the faradic or galvanic current decreases gradually in intensity and rapidly, disappearing completely in about 12 days. But there soon ensues a difference between the two currents, the degenerating muscle then showing increased reaction to the galvanic current, and also the reaction of degeneration, in which the A. C. C. is greater than the C. C. C. This reaction may increase in intensity a few weeks, then remain stationary months, or even a year or more, when atrophy of the muscles has reached completion. The reaction of degeneration is important in the treatment of such injuries.

Those cases should be treated conservatively in which the motor and sensory disturbances are slight and in which electrical examination reveals only a slight decrease in electrical excitability or a partial reaction of degeneration. In such cases there is an improvement in function in 3 or 4 weeks, although complete recovery may take 8 weeks, or even 3 months. Another class of cases in which operation should be resorted to are those in which there is complete motor paralysis and complete reaction of degeneration. Operation is also indicated when there is severe and long-continued pain. This complication is quite frequent. S. Aurbach (Deut. med. Woch., xli, 254, 1915).

TREATMENT.—Important in this connection are the conditions that may retard regeneration. Infection tends greatly to delay the progress of the process of repair. Destruction of a long segment of the nerve, the interposition between its cut ends of a tendon, muscle, bone, foreign body, or, later, of scar tissue, or displacement of the cut ends out of their normal line, are all features which tend to prevent their union and, therefore, resumption of function.

Any of the conditions that may be present having been corrected as far as possible, and the wound and neighboring area having been carefully sterilized, a constrictor bandage is applied and the ends of the divided nerve are sought and sutured.

In gunshot wounds, especially if due to a small projectile, the nerve may not be found completely divided. Expectant treatment is then indicated, since in all likelihood recovery will occur in a short time. If, however, after a few weeks function fails to return, the nerve should be exposed and the ends united with aid of one of the measures described below.

Often after minor hand injuries the patient develops pain and skin tenderness, usually some time after the injury, and rarely directly after the trauma. Very good results are obtained in operating these cases by **excising the scar tissue** and in this way freeing the nerve. Occasionally **excision of the involved portion of the nerve** is necessary, with **approximation of the ends**. In 1 case in which there was an edematous condition of the nerve the **sheath** was simply **incised**, which resulted in a diminution of its size. Usually after any work on these nerves they were covered with subcutaneous fat before the wound was sutured. These operations are easy. H. Neuhoof, *Amer. Jour. Surg.*, xxix, 143, (1915).

Nerve Suture or Neurorrhaphy.—The term **primary suture** is used when the two ends of the cut nerve are approximated and sutured immediately or soon after the injury. The wound being aseptized and an Esmarch bandage applied, the ragged

ends of the nerve are exposed, and all bruised tissue is removed. Two or three catgut sutures are then passed through both the nerve and the sheath, and tied. Unless too long a segment has been destroyed, stretching of each end may be resorted to, if necessary. The Esmarch bandage is then removed, the bleeding arrested, the wound is dressed aseptically; the limb is then placed, relaxed, on a splint. After the wound is healed the splint is removed and **massage friction, electricity** and the **douche** are used to encourage the restoration of function. This may take weeks or months, sensation returning before motion.

The ultimate outcome of a suturing operation on a nerve can be foreseen in many cases by applying irritation to the nerve below the **suture**. Some sensation is felt in the paralyzed region if the conductivity in the nerve has been restored even in the slightest measure. It is thus possible to determine the outcome weeks before actual restitution occurs. Hoffmann (*Med. Klinik*, Mar. 28, 1915).

When the ends are united a considerable time after the injury, **secondary suture** is resorted to. The chances are against its success, however, if the operation is done after more than 3 years have elapsed since the injury was received. The **trifacial** will frequently reproduce itself after the removal of segments an inch in length, while the median or ulnar tends obstinately to resist reunion.

Study of 287 reported cases of injury of nerves requiring surgical treatment in which 340 operations were performed. The sensibility and the motor functioning are less reliable criteria than restoration of the earning capacity. This was restored in 72 per cent. of the cases, partially restored in 15 per cent., and results unknown in 13 per cent. The proportion of successes was larger with secondary than with primary **suture**. Oberndorffer (*Centralbl. f. d. Grenzgeb. d. Med. u. Chir.*, June 5, 1908).

In military nerve wounds the nerve is damaged much more than is the

case usually in the injuries in civil life. The writer has sutured the nerve in 23 cases and released it from pressure of scar tissue in 13 others. Operation must be delayed until all inflammation is past, and the wounded must be informed that a complete success cannot be assured. Huis-mans, Steinthal, Dopfner and Sauter (Münch. med. Woch., Apr. 13, 1915).

When a nerve is partially or wholly divided in a bullet wound, loss of function is marked and permanent, and may even tend to increase. In these cases it is useless to expect spontaneous regeneration. The sooner nerve suture is performed the easier it is and the greater likelihood of an early cure. R. A. Stoney and H. Meade (Brit. Med. Jour., July 3, 1915).

The region being rendered aseptic and bloodless, an incision is made over the line of the nerve, the length of the incision varying with the position of the nerve, the hiatus between its ends, the interposition of scar tissue, callus, etc., any of which conditions may demand extension of the incision later. The proximal or body end should be sought first, since its bulbous end will facilitate its identification, and perhaps prove sensitive. This will point, besides, to the atrophied distal end which, owing to its tenuity, may be difficult to find. Should this prove to be the case, the incision should be extended to the nerve-trunk in its anatomical position, from which the atrophied nerve may then be traced to the site of injury.

The two ends being now available, a piece of the bulbous or proximal end is cut off and the extremity of the lower or distal end likewise. They are then approximated and sutured with catgut. As the sutures readily cut their way out, they should not be inserted too near the ends, while several should be used. Moreover, several sutures should be passed before any is tied, to prevent any one cutting its way out while another is being inserted. The wound is then treated in the same manner as after primary suture. Sensation sometimes returns after a few days,

but, as a rule, it only does so weeks or even months later.

Case of a soldier with fracture of the ulna and complete motor and sensory paralysis of the median nerve; an operation to restore the continuity of the nerve was performed 2 months after admission. Three cm. of the nerve-trunk were sacrificed. On the fourth day power in the flexor muscles had returned, though sensation was still absent. Motor power thereafter progressively increased and sensation soon returned. Salva Mercadé (Bull. de l'Acad. de Méd., Feb. 2, 1915).

It is not always possible to approximate the ends of the severed nerve in order to suture them. Bridging of the interval is then necessary. Numerous strands of chromicized catgut, along which the nerve-fibers readily grow, may be used to connect the widely separated ends. This is also termed *suture à distance*, and is the simplest and most successful method.

Results may appear only slowly, and require the aid of **massage, passive motion, electricity**, etc., to bring them about. The chances are against success in bridging gaps of more than 4 centimeters, though a few successful cases have been reported. In such cases, shortening the gap by bone resection, or lateral implantation of both nerve-ends into a neighboring motor trunk, may be advisable. A certain amount of deformity with muscle power in a limb is much to be preferred to complete and permanent paralysis. Taylor (Jour. Amer. Med. Assoc., Mar. 28, 1908).

Neuroplasty, devised by Létievant, may also be resorted to. This consists in splitting a nerve lengthwise a distance $\frac{1}{4}$ inch longer than the gap between the nerve-ends, and detaching by cutting one of the halves of the nerve in such a way as to form a flap which, by being turned back, will extend it. The free end of this flap is then sutured to the opposite nerve-end. If the gap is long, both ends may be treated in the same manner, the ends of the flaps meeting half-way between the nerve-ends.

In secondary nerve **suture** fine cat-gut should be used to unite the nerve-ends, plain if there is no tension, lightly chromicized in cases in which any tension falls on the junction. Non-absorbable materials should be avoided; they give rise in many cases to symptoms months after suture, causing relapse and seriously interfering with complete recovery. After wounds in the region of the wrist the deep fascia should always be sutured carefully. If this is not done the tendons may become adherent to the skin, and often, if the wound is extensive, a hernia of tendons forms, which is a source of weakness until remedied by operation. Sherren (*Brit. Med. Jour.*, Jan. 15, 1910).

In **nerve-grafting, anastomosis** or **implantation**, a method also devised by Létiévant, the distal end of the nerve is sutured to some adjacent normal nerve, after the latter has been vivified, or inserted in some slit in the latter. The normal nerve thus takes up the functions of the injured nerve in addition to its own. Both the upper and lower ends of the cut nerve may thus be grafted into a healthy nerve, the segment of the latter between the grafted ends serving as bridge.

Sections of nerves from a freshly amputated leg or from an animal have also been used for bridging purposes.

Case in which there had been complete section of the median nerve with a hiatus of 3 inches between the ends. Attempts to unite them with strands of catgut proved futile. About 3 weeks after the accident the wound was reopened and the sciatic nerve of a small dog was **grafted** on the freshened ends of the median nerve. Twelve months after the operation the patient was able to bend and grip anything with the last 3 fingers of the hand; the arm was strong and could be moved very freely. The sensory functions were only partially restored. Stirling (*Intercol. Med. Jour. of Austral.*, Mar., 1907).

Tubulization.—Union of the sutured nerve-ends or grafts may be interfered

with by scar tissue formed in the adjacent structures during the process of repair. To prevent this various means, known under the general term **tubulization**, have been tried. A solid cylinder of decalcified bone or of absorbable magnesium may be made to contain the sutured ends; gelatin, silver-foil, and corgile membrane have also been tried.

Trials in a personal case indicated that bridging by tubules or loop stitches is unsatisfactory, and that **implantation** or **direct suture** by forced joint positions are the more desirable methods. Steinthal (*Beitr. z. klin. chir.*, xcvi, 295, 1915).

Murphy employed a mixture of equal parts of the paraffin and oil of sesame, which may be pressed out into thin sheets and may be wrapped around the sutured nerves. If available, neighboring fascia, fat or even muscle, may be used as protective covering. Finally, as suggested by Oellis, shortening of a limb by resecting a piece of its bone or bones may be resorted to, in order to permit approximation of the ends of the nerve.

Two cases of bullet injury of nerves leaving persistent pain in the calf in 1 case and anesthesia and paralysis of part of the hand in the other. In both the nerves involved were found imbedded in cicatricial tissue. Treatment was restricted to **mobilizing the nerve and moving it** over to a region where it lay between layers of sound muscle, apart from the injured region. The pains subsided in less than 2 weeks, and in 6 months function was almost normal. Hashimoto and Tokuoka (*Archiv f. klin. Chir.*, lxxxii, nu. 1, 1907).

Six months after injury in a personal case the nerve was exposed and found to be severed above where it divides into the radial and interosseous; the ends were not widely separated and were caught in the scar tissues of the wound; each end showed a bulb formation of the nerve and scar tissues. These were excised and the nerve-terminals **sutured** together with fine catgut in an absorbable tube prepared from the

artery of a cow after Foramitti's method, slightly modified. The wound was closed without drainage and a cast was applied with the arm at right angles. The arm and hand were perfectly normal at the end of a year. Torrance (N. Y. Med. Jour., June 17, 1911).

Early **exploratory incision** and repair advocated in nerve trunk injury. To prevent nerve adhesions at the site of repair, fascia and fat are alone useful, with the latter the favorite. **End-to-end suture** or tubulization gives better repair than lateral implantation. The scar must be excised to normal axis cylinders as indicated by a granular surface on the nerve-end before repair is done. Three fine **silk sutures** are used to approximate the ends, and then a free **fat transplant** is placed around the line of union. This is stitched to complete the tubular form and then fixed by suture to adjacent tissues. D. D. Lewis (Surg. Clinics, 1, 103, 1917).

Neurolisis combined with a capsulectomy of spindle-shaped neuromas has been followed by recovery in most, and improvement in all, cases in which this has been done; exsection of a spindle-shaped neuroma is not justified unless failure has resulted from a **neurolisis capsulectomy**. **Nerve transplantations** and double **lateral implantations** of the ulnar into the median in the forearm, have been followed with some measure of success; but recovery is slow and uncertain.

Axis cylinders, judged by Tinel's sign, grow at the average rate of 2 mm. a day.

Perineural scar tissue constricting young axis cylinders is the most important factor in hindering recovery. Joyce (Brit. Jour. of Surg., Jan., 1919).

Peripheral Nerve Injuries.—These are mainly met in the upper extremities, and chiefly in the clavicular region, thus involving the brachial plexus. Not infrequently the cranial nerves, especially the facial nerve, are injured. Injury to the nerve-roots is very rare. The pain is

often very severe. When any movement causes stretching of the nerve it is apt also to be of long duration.

Intra neural injection of alcohol used in 21 cases of painful neuralgia following gunshot wounds of nerves, recovery resulting in each case. About 3 to 4 centimeters above the seat of the wound a fine hypodermic needle is introduced and about 1 to 2 c.c. (16 to 32 minims) of 60 per cent. sterilized alcohol—or even 80 per cent., if the neuralgia is of long standing—is injected. Sicard (Lancet, Feb. 9, 1918).

Every case of paralysis from nerve injury should have an appropriate **splint** applied and continuously used until disappearance of the paralysis. It should prevent overstretching of the paralyzed muscles and deformity due to contractures, and allow harmless movement of the part and treatment without removal of the splint. M. Langworthy (Amer. Jour. of Orthop. Surg., 16, 445, 1918).

Report of results obtained in 358 cases of nerve wounds treated surgically. **Resection and suture** is the method of choice, yielding successful results in 88 per cent. When resection is so extensive as to prevent approximation of the 2 ends, even with the limb flexed, it should be done in 2 stages.

At the first operation the largest possible section of nerve should be removed and the diseased ends sutured together.

Some months later, after the nerve has become stretched, further resection and suture of healthy nerve ends can be effected. In still more extensive loss of nerve tissue, **nerve grafting** should be performed, either with the aid of 2 fragments from the musculo-cutaneous side by side, or a piece of nerve from an amputated limb. Delagenière (Presse méd., Oct. 17, 1918).

It is not very often that infantry missiles lodge in or near the nerve. As in case of the brain the shots which graze are very deceptive, as they frequently re-

sult in deposit of particles in the nerves. When a foreign body is lodged in or near a nerve the indication, of course, is to remove it.

In subcutaneous nerve injuries operation should be resorted to if, after the first effects of the trauma upon the soft parts have passed away, no improvement in motility has occurred, and also if neuralgic symptoms or a degenerative reaction ensue. The procedures consist in **paraneuromy, division of the nerve-sheath, nerve-suture, and imbedment.** In cases of paralysis occurring *intra partum*, which usually involves the brachial plexus, early intervention is also indicated, especially in the presence of a degeneration reaction. Borchard (Beitr. z. klin. Chir., Bd. 91, Hft. 3, 1914).

Injury of the vagus is liable to slow the pulse and the respiration. Severing the vagus nerve on one side does not cause any threatening symptoms on the part of the heart or lungs. But irritation of the nerve is liable to induce extremely severe symptoms, possibly complete arrest of heart and lung action. In some cases there are also more or less dyspnea and spasmodic coughing. When severe symptoms develop, the writer advocates **vagotomy.** The only drawback is the permanent paralysis of the vocal cord. The vagus nerve sometimes stands traction, compression, etc., but it is more liable to respond with serious symptoms. If cautiously and gently manipulated it will stand a great deal, especially if treated with **cocaine** beforehand. Zesas (Centralbl. f. d. Grenzgeb. d. Med. u. Chir., Mar., 1915).

As regards operative indications an important feature is that it is rare to have a nerve severed; also that a shot penetrating near a nerve may cause paralysis without direct injury to it, because it is imbedded in a bloody, gelatinous exudate, which also infiltrates it. The principal indication for operation lies in the necessity for freeing the nerve from a scar.

The indication for operation upon a nerve because of pain is not clear and decision is difficult. One should operate in such cases only when other means of treatment fail. Unfortunately in war one sees at times ischemic paralysis of the nerves due to the use of the Esmarch bandage, which may be left on from 10 hours to 3 days. The prognosis in these cases is hopeless.

The beneficial effects of nerve-suture often are not manifest for as long as 8 months. The results of neurolysis become evident sooner, function often being restored after 2 months.

Among 502 wounded soldiers observed by the writer, 52 presented injuries of nerve-trunks or centers, and of these 27 showed wounds of the nerves in the extremities. Where paralysis alone exists, without pain, the writer does not operate until the wound has entirely healed, in order that the intervention may be conducted under aseptic conditions. In painful cases, however, experience has shown that, where the distress cannot be relieved by medical means, an operation is justified, not only because of the pain itself, but on account of the danger that increasing injury will be done to the nerve through contraction of cicatricial tissue. Extensive removal of any superficial cicatricial tissue, together with the deep-lying indurated mass, was effected. Once exposed, the nerve was carefully freed from adherent cicatricial remnants, being meanwhile kept moist with normal saline solution.

The most important feature of the operative technique is the interposition between the nerve and the surrounding injured tissues of layers of normal muscular tissue taken in so far as possible from the surrounding muscles. These layers are sutured to the tissues which would otherwise be in contact with the nerve, and preserve the latter from subsequent cicatricial compression. Walther (Bull. de l'Acad. de Méd., Nov. 10, 1914).

Besides the liberation of a nerve from surrounding cicatricial tissue, injection of 2 c.c. (32 minims) of normal saline solution containing 0.005 Gm. ($\frac{1}{2}$ grain) each of cocaine and stovaine into the nerve-trunk for 4 to 6 cm. is recommended. Where a nerve, upon exposure, is apparently normal, being thus merely in a state of inhibition or stupor, injection into the nerve-trunk of 1 to 2 c.c. (32 minims) of a 1:100 solution of chemically pure methylene blue in normal saline solution prepared with distilled water is advised. Sicard, Imbert, Jourdan and Gastaud (Bull. de l'Acad. de Méd., Feb. 16, 1915).

In operating on nerves injured by a bullet or fragment of a shell the nerve should not be separated from its bed until the last minute, as the stumps must be guarded against twisting. This would prevent coaptation of the fiber tracts. Stretching of the stumps to bring them into contact should be done before the ends are freshened. It is usually necessary to pass the needle through some of the nerve-tissue itself to obtain a stout hold. When this is the case, the sensory tracts should be selected, carefully avoiding touching the motor tracts. Stoffel (Münch. med. Woch., Feb., 1915).

In nerve suture the writer found it feasible, by using fine silk and the finest needles obtainable, to suture the perineum without injury to the axis cylinder fibers. Frouin (Presse méd., Jan. 8, 1917).

Tinel's sign of distal tingling on percussion depends upon the fact that the percussion of young axis cylinders leads to tingling in the skin areas corresponding to their ultimate distribution. The formation of new axis cylinders in the proximal end of a divided nerve becomes evident by the above sign in from four to six weeks. W. M. Macdonald (Brit. Med. Jour., July 6, 1918).

Experiments showed that direct nerve suture exposes the limb to serious trophic disturbances of the muscles and skin. These are obviated by

interposition of a short dead nerve transplant. The indirect suturing is done with 2 or 3 silk threads passed through the neurilemma. The dead transplants are obtained aseptically from calf fetuses 50 to 60 centimeters long, easily procurable at slaughter houses. They are fixed in 50 per cent. alcohol and kept in sealed tubes. Only 4 threads are used to hold them in place. These transplants remain at least a few weeks before absorption. Such treatment is practicable only in recent nerve injuries. Nageotte (Paris méd., July 20, 1918).

Nerve suture should be so performed as to prevent improper distribution of fibers. This can be done by careful observation of the oval contour of the nerve and correct approximation of the 2 ends. Reformation of scar tissue is prevented by accurately bringing together the neural sheaths. When the gap is too great for direct suture, one should insert a homogeneous graft taken from a mixed nerve of equal or larger size than the injured one, *e.g.*, from amputations or amputation stumps requiring a secondary operation. E. W. Fisher (Brit. Med. Jour., Apr. 26, 1919).

The following operative procedures, not already referred to, are sometimes indicated:—

Nerve Stretching or Neurectasy.—This operation has been employed in many nervous disorders, but particularly in the various forms of neuralgia, including that of such large nerves as the components of the brachial plexus and the sciatic. In performing it the nerve is exposed, and isolated by a blunt dissection. It is then grasped by suitable tractors or with the thumb and finger, and stretched from both directions, central and peripheral, until the nerve is plainly elongated. The conductivity of the nerve is lessened, and it is separated from any cicatricial or other tissue which may compress it.

The best results are obtained in sciatica, and in supraorbital neuralgia. The sciatic nerve will stand a pull which will raise the limb from the table, but jerking should

be carefully avoided, while the traction, which may last from 3 to 5 minutes, is exerted.

Nerve Extraction or Avulsion.—This method, devised by Thiersch in 1889, is more effective than neurectomy in the treatment of **trifacial neuralgia** and **tic douloureux**, and is less serious than operations about or removal of the Gasserian ganglion. Under general anesthesia the painful nerve-trunk is exposed, then grasped with blunt forceps, and slowly twisted round the forceps in such a way as to pull the nerve out of its bed and its connections. Segments of the nerve, from 5 to 8 inches in length, may be readily removed by this procedure.

Even here, however, regeneration of the nerve may occur from previously inaccessible fibers. When the nerve issues from a foramen, such as the supraorbital, the latter may be plugged with bone grafts (Kanavel), silver screws (Mayo), amalgam, gold- or silver- foil, etc., to prevent regeneration.

Neurotomy.—This consists in dividing the painful nerve, and was largely done at one time in the treatment of **neuralgia** and **tic douloureux**. Unfortunately, the relief is but temporary, the average freedom from pain, according to a review of 43 cases by Putnam and Waterman, being but 10 months. In some instances only a few weeks' relief was afforded.

Neurectomy.—This operation consists in exposing the painful nerve in neuralgia or **tic douloureux**, etc., and removing either by cutting or extraction of segment of the nerve. As ably described by Urban Maes, of New Orleans (*Surg. Gynec. and Obst.*, Oct., 1915), the operation is carried out in the following manner in the regions specified:—

The supraorbital branch of the first division is best reached by a curvilinear incision in the eyebrow. The skin, fascia, and fibers of the orbicularis are divided. The nerve lies between the two layers of periosteum near the junction of the middle and inner thirds of the orbital ridge where a notch may be felt. After exposure of the nerve, which should be carefully separated from its accompanying vessel, it may be avulsed by the method of Thiersch.

The second or superior maxillary division is the branch most frequently affected, according to Spiller. It makes its appearance in the face at the infraorbital foramen, which is in a vertical line with the supraorbital notch, just below the margin of the orbit. In this region it may be exposed on the face and avulsed or subjected to an injection of 1 to 2 per cent. osmic acid or 80 per cent. alcohol. The failure of this operation caused Kocher to devise a method of resection at the foramen rotundum, which is described in his book, which is a thorough treatise on the surgery of the trigeminus. The incision is in the same curvilinear line as for the peripheral operation, but is carried farther back, at the same time avoiding injury to the fibers of the facial and being well above Steno's duct. All structures attached to the malar bone are pushed aside with a periosteotome, up to and including the floor of the orbit. The chisel is then used to cut into the sphenomaxillary fissure and to open the antrum. This opens the infraorbital canal. The frontomalar articulation is divided with a chisel, and finally the malar-zygomatic articulation. The malar bone is then dislocated outward and upward where the nerve can be followed and avulsed up to the foramen rotundum, care being taken not to injure the accompanying artery. The malar bone is then replaced. There is some risk of infection in this operation, and, as already noted, the antrum is opened.

For division of the trunk of the inferior maxillary after its exit from the foramen ovale, either Kocher's or Kronlein's operation may be used. In Kocher's operation a curvilinear incision with its convexity downward is made from just behind the frontomalar articulation to the root of the zygoma. This incision includes all structures and divides the temporal vessels and a branch of the facial nerve to the occipitofrontalis. Retracting the edges of the incision exposes the zygoma, which is divided but left attached on its under surface. After removing the underlying fat, the posterior border of the temporal muscle is drawn forward, exposing the periosteum along the pterygoid ridge. This periosteum is divided and elevated

from the bone along with the soft parts so as to avoid the internal maxillary artery. This dissection is carried back until the base of the pterygoid process is seen, and just posterior and to the mesial side of this process we find the foramen ovale at a depth of about 3 cm. from the root of the zygoma. The trunk is then divided or avulsed according to the method of Thiersch.

The inferior dental branch of the third division may be reached by any one of three routes, although the intrabuccal method is accompanied by too much risk of infection to make it practical. In order to avoid a visible scar the incision is made just around the angle of the inferior maxilla, through all structures to the bone. With a periosteotome the tissues are elevated from the under surface of the ascending portion of the ramus until the foramen is reached, which is identified by the spine of Spix. The nerve can then be caught with a hook and avulsed. Another method is to approach the nerve by trephining the jaw just opposite the foramen, which is located just in the center of the irregular quadrilateral formed by the ascending portions of the ramus. A skin incision is made down to the masseter, which is separated in the direction of its fibers. A small trephine is used to perforate the bone, and the nerve avulsed, avoiding the accompanying artery.

Even this operation may be followed by recurrences. The more radical operation described under the next heading may then be resorted to, but only after all other measures have been tried.

Removal of the Gasserian Ganglion or of Its Sensory Root.—This operation, first proposed by J. Ewing Mears, is classed by Deaver among the "relatively safe" operations, "while for efficacy there are few superiors," though acknowledging that his mortality had been higher than that given by Frazier and Keen, viz., 3.7 per cent., in a total of 230 cases. Spiller has shown, however, that removal of the ganglion was not necessary, division of its sensory root being sufficient. Frazier describes the operation as follows:—

The essential feature of this operation is the division or avulsion of the sensory

root exclusively without interfering with the ganglion itself. The approach to the ganglion is made through an opening somewhat posterior to that employed by other surgeons. The center of this opening is about on a line with the point at which the sensory root passes into the ganglion.

Under nitrous oxide-ether anesthesia, preceded by the administration of a hypodermic injection of morphine (grain $\frac{1}{4}$ —0.01 Gm.) and atropine sulphate (grain $\frac{1}{100}$ —0.00065 Gm.), with the patient in a vertical posture, a horseshoe-shaped incision is made, beginning about the middle of the zygoma and terminating behind and a little below the helix of the ear. The musculocutaneous flap, purposely made a little larger than the opening in the skull, is reflected, the skull opened, and the opening, with a diameter not exceeding 3 cm., enlarged as far as the infratemporal crest. The dura is separated from the base of the skull with a blunt instrument, such as the handle of a scalpel, as far as the foramen spinosum, where the middle meningeal artery is ligated and divided distal to the ligature. The dura propria is incised directly over the mandibular division and dissected from the superior surface of the ganglion backward and inward until the sensory root is exposed. If the motor root can be recognized, it should be isolated. The sensory root is then picked up with a blunt hook, grasped with forceps, and either divided or avulsed. Hemorrhage is controlled by strips of gauze not more than 1 cm. in width, introduced at either side so as not to interfere with continuation of the operation. As soon as the sensory root has been divided the anesthetic is discontinued. When the reflexes have returned, the conjunctival reflexes should be tested in order to assure the operator that no fibers of the sensory root remain undivided. The musculocutaneous flap is closed with tier sutures and a small narrow strip of rubber tissue introduced in the posterior angle of the wound. It is almost always necessary to provide for the escape of blood, inasmuch as only exceptionally will the field be entirely dry when the operation is concluded. (This is accomplished by a rubber-tissue

drain.) The rubber tissue is removed within 24 or 48 hours. This operation is now preferred, because it is less likely to involve the fibers of the facial, which brings on ocular complications of a serious nature, while the small opening made reduces the likelihood of hernia.

Removal of the Cervical Sympathetic.

—This operation has been advocated by Jonnesco and others in the treatment of exophthalmic goiter, epilepsy, and other disorders, but, in view of recent progress, is not to be recommended. S.

SPINAL MENINGITIS. See MENINGITIS.

SPINAL PARALYSIS, INFANTILE. See SPINAL CORD, DISEASES OF: INFANTILE PARALYSIS.

SPINAL PARALYSIS, SPASTIC. See SPINAL CORD: PRIMARY LATERAL SCLEROSIS.

SPINE, DISEASES AND INJURIES OF.—TUBERCULOSIS OF THE SPINE.—(Pott's disease; spondylitis).—Tuberculosis of the vertebræ makes up nearly all the cases classed under the head of Pott's disease, so called because of the very elaborate account given of it by Percival Pott over a hundred years ago.

The subject of BONE TUBERCULOSIS has already been discussed (see volume ii), under the head of HIP-JOINT DISEASE (see volume vi) and, under the head of ARTHRITIS, TUBERCULOUS (see volume vi). What was then said of the growth of tubercle in the femur and joints also applies to tuberculosis of the spine.

SYMPTOMS AND DIAGNOSIS.

—As a rule, the primary focus of disease in the cancellous tissue of the body of a vertebra spreads slowly until the intervertebral cartilages connecting this vertebra with its fellows are involved. It is rare for the

disease to remain confined to a single vertebra. It more usually involves several contiguous vertebræ, or there may be present several spots of inflammation, at different locations in the spine, some of which may appear months or even years after the primary infection. The vertebral body is gradually destroyed, and usually, unless support is applied to the spine, the superincumbent weight of the body crushes together the softened vertebræ, causing an angle in the spinal column, with a protrusion of the spinous processes. As a rule, the erosion has been toward the front of the bodies of the vertebræ, and the angle takes an anteroposterior position accordingly. But it occasionally happens that a marked bend to one side takes the place of the ordinary anteroposterior deviation. It occasionally happens also, that large amounts of the cancellous tissue are destroyed, even the entire bodies of two or three vertebræ, without the occurrence of deformity, as enough inflammation has occurred to cause proliferation of bone between the transverse processes, the vertebræ becoming firmly ankylosed in a straight position.

Sometimes the seat of the disease is in a costovertebral articulation. This point must be borne in mind in making a diagnosis before excluding vertebral tuberculosis. Very rarely the focus of disease is found in the transverse arch or in the spinous process of a vertebra.

Abscess formation often accompanies vertebral tuberculosis. The abscess may extend into the vertebral canal, giving rise to paralysis. It may also point anteriorly, and may cause such pressure on the trachea or bi-

furcation of the bronchi as to impede respiration. It may rupture into a bronchus and the pus be expectorated or it may cause suffocation; it may set up a pleurisy; or it may perforate the bladder or the rectum; but usually such abscesses, if in the dorso-lumbar region, burrow a tract along the course of the psoas muscles, and point either below Poupart's ligament or above the posterior iliac spines.

In the cervical spine these abscesses at times burrow until they penetrate the mediastinum, with most disastrous consequences, or may rupture into the pharynx, the pus setting up an intestinal tuberculosis.

A diagnosis must be made between spinal tuberculosis, syphilis, and rickets, and this may be very difficult. If the child be under 2 years of age, and have several foci of disease in the spine, several other joints involved, or show evidences of syphilis elsewhere, or the parents be known to be syphilitic, it should receive anti-syphilitic treatment in addition to protection for its spine. A negative Wassermann reaction does not necessarily exclude syphilis.

If evidences of rickets show themselves in large epiphyses, beaded ribs, open fontanelles, abnormal sweating about the head, the spinal curvature is probably rachitic. Benefit will follow changing the diet and administering phosphorus and codliver oil. The necessity for supporting the spine is, however, as great as if tuberculosis were present; but the chances are that it will be required for only a short time.

Many tuberculous cases do not prove fatal, and, if adequate mechanical support is applied before the occurrence of a deformity, the latter

should be largely prevented. **Absolute rest of the inflamed area** and the **building-up of the patient's nutrition** are the two essentials of treatment. A certain percentage under the best of care does not improve, but develops abscesses and amyloid changes in the viscera, or develops pulmonary or meningeal tuberculosis, especially the latter.



Lumbar Pott's disease, with beginning psoas abscess, simulating lateral curvature of the spine in the position patient holds her body. (R. H. Sayre.)

Early diagnosis is important, as the disease precedes the deformity for some time, and, as elsewhere, is more easily prevented than cured. Pain, muscular spasm, and slight elevation of temperature are the three diagnostic points to be noted. The pain is referred to the distal extremity of the nerves which pass from the spine at the point of inflammation, and the symptoms, as a result, vary. In the

first and second cervical vertebræ occipital headache may be noted, and the condition may resemble *torticollis*. In *torticollis*, however, the face looks upward and away from the contracted muscles, while in cervical tuberculosis the face, though turned to one side, is more often directed downward. In *torticollis* pain is not present, and the muscular spasm, pathognomonic of joint inflammation, does not exist: simply a chronic contracture of certain muscles. Fever of 99° or $99\frac{1}{2}^{\circ}$ F. (37.2° or 37.5° C.) will also probably be found associated with tuberculosis.

One symptom which is pathognomonic of inflammation in the first and second cervical vertebræ is pain, or sometimes a sense of impending death on being placed recumbent. The patient may be unable to lie down to sleep for weeks at a time, until adequate support is applied. The anatomical construction of the first and second vertebræ accounts for this peculiarity. While recumbent, the weight of the head presses the body of the atlas back against the odontoid process of the axis, while in the upright or slightly anteflexed position the latter is freed from pressure. Recumbency gives relief when the disease is in any other portion of the spine.

With this particular location a prognosis must always be reserved, as there is possibility of entire erosion of the odontoid process or rupture of the check ligaments and consequent fatal pressure on the cord,—unless ankylosis of the vertebræ has occurred previous to the odontoid destruction.

A little lower in the neck the disease causes dyspnea and a kind of

breathing, somewhat resembling the noise of croup or whooping-cough, while at the dorsocervical junction the disease at times produces auscultatory sounds which exactly resemble a general bronchitis, and which disappear when traction is made upon the head, to reappear again the moment it is relaxed. In the majority of cases of upper dorsal disease there is a peculiar grunting respiration which is pathognomonic, and once heard cannot be mistaken.

When the disease is situated in the dorsal region, pain may be referred to the front part of the chest or pit of the stomach, and the diagnosis of indigestion made in consequence, while, when it is a little lower in the spine, the child is often treated for worms and colic. Here also, pain may be referred to the bladder, perineum, or the rectum. In the lower lumbar region hip disease may be suspected, the pain being referred to the inner side of the thigh and to the knee. At times, sharp contraction of the abdominal muscles may be noted, before the appearance of a knuckle in the spine, giving the appearance of a string tied tightly around the belly.

Pain is rarely felt at the point of disease, except when of long standing, and this pain is usually elicited by blows and jars or sudden twisting of the spine, and not by direct pressure; often, if the patient be laid face downward and pressure made on the knuckle, relief will be given, due to removal of pressure from the inflamed surfaces.

The gait is characteristic. There is a careful, apprehensive tread, the ankles, knees, and hips being flexed to avoid jarring the spine; and the patient steps upon the toes. On bending

to pick up an object a child with Pott's disease will flex the ankles, knees, and hips, and squat down, and in walking around a room it will frequently support itself by the table, chairs, etc., taking care not to release its grasp of one until it has secure hold of another. If compelled to walk by itself, it may support its trunk by placing both hands on its thighs and stiffening the arms, thus relieving the spine of pressure. Usually these patients find that riding in street-cars or on rough pavements causes pain, and that they are obliged to place their hands on the seat of the carriage, thus supporting the body. If the disease is high up in the spine, the head is frequently supported by the fingers, and on looking to either side the entire body is rotated, and not simply the neck. When the disease is in the dorsal region the child often walks with the head thrown back, the face looking toward the sky, to relieve the front part of the vertebral bodies from pressure, and a mistaken diagnosis of cervical disease be made in consequence.

The diagnosis is simple in the presence of deformity, but long before this symptoms are present which, properly interpreted, permit a correct diagnosis. It is important that the patient's trunk be stripped, and the attitude noted. The patient should bend forward and backward and to both sides, the occurrence of spasm in any of the muscles of the trunk being carefully noted. Marked tenderness to pressure along the entire spine, without muscular spasm or deformity is a pretty sure indication of the so-called "hysterical" spine. If spasm be found on any manipulation

of the spine, any pain on bending or on concussion, with pains referred to the anterior part of the body, combined with a one degree fever, the condition is almost certainly an inflammation of the spine, even without any deformity.

In such cases, one should examine the costovertebral articulations, taking the ribs one by one and pressing their heads against the vertebræ to detect any inflammation. In doubtful cases if there is fever, inflammation is probable in the spine, which should be protected accordingly until time shall have cleared up the diagnosis.

ETIOLOGY.—An injury can frequently be traced as the exciting cause. The customary gradual onset, however, causes observers frequently to overlook the connection between the traumatism and the disease.

TREATMENT.—The treatment should consist of **physiological rest of the inflamed vertebræ**. *In children under 3 years of age*, this is best secured by **recumbency** in a wire **cuirass** comfortably padded and made to fit the shape of the entire child. The legs and the body are bandaged to hold it firmly in position; **traction** is then made **upon its head** by means of a leathern head-support, which passes under the chin and occiput, and is attached to a cross-bar which is suspended from an upright fastened to the cuirass. Without this traction, a knuckle is very sure to develop from reflex muscular spasm, in spite of the recumbent position.

If the disease is in the *upper dorsal region*, the shoulders should be held by the attachment suggested by Dr. Whitman, which consists of two

hard-rubber caps which fit the heads of the humeri and which are connected together by a steel rod passing across the front of the chest; the straps pass above and below the shoulders from buttons on the rubber caps to the back part of the cuirass, and the **shoulders** are thus held thrown well backward.

The use of straps passing around the shoulders to hold the latter back is decidedly less efficacious than the **Whitman apparatus**, which controls better the movement of the vertebræ.

In the cuirass the child may be taken out in a large baby carriage, and receive the benefits of **sunshine** and **fresh air**. The **bandages** should be removed every day, and the child's skin kept in proper condition. Every few days, if need be, the child may be removed from the cuirass, by rolling it on its stomach, and washed with water and a little alcohol. This is preferable to **recumbency** in a cot, with **traction on the head with weight and pulley**, as in the cuirass the child may enjoy the benefits of **outdoor life** and be carried up and down stairs. The invalid child should pass most of its time **recumbent**. If simultaneous disease of the knee or hip is present with *spinal tuberculosis*, the cuirass is also the proper treatment. The **Bradford frame** of gaspipe over which is stretched a canvas cover is preferred by many to the cuirass, but in the writer's opinion gives much less quiet to the spine, especially if the disease is dorsolumbar.

If the child be larger, and the pelvis enough developed, **apparatus** may be applied to allow the child to walk.

If the disease is in the *cervical region*, a **jury-mast** should be applied, which may be fastened to either a

plaster jacket or to a **steel back-brace**. If the latter is used, it must receive support either from the shoulders of the child or from the crests of the ilia, the latter being the best point from which to make upward traction.

If the disease is in the first or second cervical vertebra, the head must be held absolutely rigid with a **metal head-support** fastened in position by a brow-band and connected to a **body-brace** by a rod having universal joints at the occiput and seventh cervical vertebra, in order that the apparatus may be adjusted to the head in its position of distortion and gradually altered as the subsidence of inflammation permits.

If the head is not turned far from a straight line, simple uprights of iron bent to fit the shape of the neck and head may suffice, the ordinary **jury-mast** being used for this purpose. If it is not practicable to obtain such an apparatus, **plaster-of-Paris bandages** enveloping the head, neck, and trunk, like a suit of armor, may be used with success. In fact, I believe the plaster of Paris simpler and better.

In the lower cervical vertebrae rotation may be permitted.

If the disease is in the upper dorsal vertebrae, any **apparatus** used must sustain the weight of the head, whether it be an anteroposterior steel brace or a plaster jacket.

With the disease in the dorsal region, the spine may be supported with the **anteroposterior steel brace**.

A **spinal brace** should be made of steel so tempered as to be capable of being bent by a large pair of monkey wrenches, and should be accurately fitted so as to support the entire spine. There should be two back-

bars, one lying on each side of the spinous processes, and connected by cross-rods so curved as not to press on the spine. There should also be a pelvic belt, with padded bands attached, which pass over the iliac crests in order that the weight of the head may be transmitted down here. Control of the head is obtained by a metal rod passing from the back-bars of the brace over the top of the head, and supplied with a cross-bar from which depends a **leathern head-support** passing under the chin and occiput. From the back-bar project other bars which pass behind the scapulae and project a trifle over the shoulder, and from these straps pass in front of the shoulders and under the axillæ, and fasten again to buckles on the back-bars. The reason these bars project above the shoulders is to prevent the straps from crowding the shoulders down, as they are only intended to force them back. As the straps by themselves would slip into the fold between the humerus and the chest, they are kept from so doing by fastening them to two concave rubber caps which rest against the front of each humerus and are connected by a curved metal bar, according to Dr. Whitman's suggestion, which keeps them apart. A linen apron with straps to the back-bars keeps the entire apparatus in place. It should be fitted with great care. The patient should be prone and the spinal outline taken with a strip of flexible lead or other metal and the back-bars then properly bent with wrenches. The bars may require to be twisted sidewise as well as in an anteroposterior direction and should be so adjusted that *when the patient is upright the entire spine is thoroughly*

supported. This is difficult in case of decided deformity. The fitting of such apparatus should be done by the physician himself in his office; upon the perfection of support will depend the benefit derived.

In many cases the improving position requires straightening of the back-bars from time to time.

In my experience better results are obtained from the use of the **plaster-of-Paris jacket** than from any other means of support except in *cervical and high-dorsal cases*, where a **steel brace** is preferable.

The Plaster-of-Paris Jacket.—Cross-barred muslin or crinoline should be the material used in making the bandages. This muslin should be carefully washed to get rid of the superfluous sizing before being torn into strips from three to four inches in width and three yards in length. "Phelps hospital crinoline" does not, however, require washing. The selvage is to be torn off. These strips are drawn through a tray filled with freshly ground plaster of Paris, and enough rubbed into the muslin to fill all the meshes. The bandages are then rolled moderately tight and laid in an air-tight tin until required.

The patient should have the body covered with a tightly fitting knitted or woven shirt, without sleeves, tied tightly over the shoulders and drawn down and securely pinned over a folded towel in the perineum with a safety-pin. If the patient is a female, pads of proper thickness should be placed over the mammæ and under the shirt, which pads are to be removed when plaster sets. Another towel, the "dinner pad," also to be removed after the plaster sets, is placed inside the shirt, thus provid-

ing space for the expansion of the stomach. If the patient has just partaken of a hearty meal, this dinner pad may be omitted. A felt pad should be placed along the spine, being pinned to the top edge of the shirt, and felt pads placed so as to protect the iliac crests on each side. These pads are left in the jacket.

The patient, now being prepared, is placed in the suspension apparatus, which consists of a pair of padded straps, which pass under the axillæ, and a leathern head-piece which passes under the chin and occiput, all of which are suspended from an iron rod, which, in turn, hangs from a compound pulley suspended from the ceiling, door, etc. In patients' houses a folding tripod of wood is very convenient. Traction is now made on the head and arms evenly, the straps being lengthened or shortened until the pressure is evenly distributed.

Traction is now made very slowly and gently, and only carried to the point of giving the patient perfect comfort, and never beyond that point.

In some cases the heels will be slightly raised from the floor before this point is reached; as the sensations of the patient are the only guide as to the amount of traction needed, an anesthetic should under no circumstances ever be given. If it is a young child, watch carefully the expression of its countenance; and when it is changed from pain to pleasure, there always stop, and immediately apply the plaster bandages with great care and accuracy, pressing them into all the irregularities and covering the entire trunk from the pelvis to the top of the sternum.

If the patient is kept suspended in this position till the plaster is set, it

will retain the body in perfect comfort.

In applying the bandages one of them should be placed on end in a basin or pail of tepid water. When bubbling ceases, the bandage is ready. Do not add salt to the water, as it renders the plaster brittle. Squeeze out the superfluous water before applying it, and place another roll, end up, in the water, which will be ready for use by the time the first one is applied.

It is not a bad plan to immerse the bandages while wrapped in thin Japanese paper napkins. The bandages are then one by one laid in a dry basin to drain while the preceding bandage is being applied. In this way much less plaster is left in the bottom of the pail to be gotten rid of.

The patient being suspended, the jacket is applied by the surgeon, standing or sitting at the back of the patient, while an assistant sits in front, steadying the patient by his knees and rubbing and smoothing the bandages which are being applied.

Begin at the waist, taking one or two turns around the smallest part of the body, and then going down in a spiral form, each layer overlapping the other half or two-thirds of the width of the bandage until reaching the trochanters; then, having taken one or two turns around the pelvis, reverse the bandage and gradually proceed in the same spiral manner upward until the body is covered.

This process is repeated till the jacket is sufficiently thick to support the body, the number of bandages depending on the size of the patient.

In cases *where the disease is in the lower dorsal or lumbar vertebrae* this is all that is required. *If the disease*

is at the *middorsal or cervical vertebra*, it then becomes necessary to add the **jury-mast** to the jacket in order to take off the weight of the head.

In many instances great advantage is derived from the addition of **Whitman's shoulder brace** to keep the chest well expanded, and press the shoulders back into the jacket.

Several modifications have been made in the application of plaster bandages, as **Davies's hammock**, in which the patient was suspended, face downward, while traction was made on the head and heels by an assistant. Goldthwaite, of Boston, has advocated traction by a windlass, with the patient lying on the back, the most prominent part of the curvature being supported by a little upright, the weight of the patient's head and shoulders tending to correct the deformity. Goldthwaite thus claims great improvement in curvature of the spine in various cases, and in properly selected cases this position is preferable to vertical suspension.

Taylor, of Baltimore, applies plaster jackets, the patient being fastened to a bicycle saddle, while pressure is made against the kyphos and the sternum by means of arms which project from the **apparatus**, while traction is made on the head, upward and backward, by means of a pulley.

In the great majority of cases the jacket can be applied while the patient is suspended vertically; where there is paralysis, where the heart is too weak to allow the patient to remain upright, or in excessively fat and feeble people, **Davies's hammock**, with holes cut to allow projection of the head and feet, or **Goldthwaite's apparatus** is to be preferred, traction being made at both ends of the body

to the point of comfort while the jacket is being applied.

Management of Abscess.—Opinions differ widely as to the proper mode of procedure. If the patient is doing well, with a temperature below 100° F. (37.7° C.), appetite and digestion good, it is wise not to interfere, especially if the disease is between the first and twelfth dorsal vertebrae, as the chances for the removal of all tuberculous material and disease foci do not warrant the risk of a mixed infection. *If the abscess has approached near the surface and seems about to burst*, it is wisest, in most instances, to **cleanse the skin thoroughly**, and apply an **antiseptic dressing**. *When the abscess discharges*, this **dressing** should be **changed** as frequently as required, care being taken to prevent infection of the wound at such times.

The patient should take much more **rest** when abscesses are present, as they increase in size much more rapidly if children run about.

If the abscess has become infected with pus organisms, a **free incision** should be made, either in front or in back, or both, according to the situation of the abscess, and the **abscess cavity** freely laid open and washed out with **hot Thiersch solution**. If conditions permit, the **abscess cavity** should be explored and all **carious bone removed**. In dorsal disease it may be necessary to **resect the head of a rib** in order to secure sufficient space to thoroughly explore the spine. Great care should be taken to push the pleura in front of the finger, and not tear it in approaching the vertebra.

There must be **short and direct drainage** to the initial point of in-

flammation; otherwise these abscesses are apt to form sinuses which run for years, become secondarily infected and finally set up amyloid degeneration of the liver and kidneys.

In the upper cervical vertebrae an abscess may point in the back part of the pharynx, and the question may arise whether to open it through the pharyngeal wall or from the outside of the neck. There are many objections to the former procedure.

In case the abscess is increasing in size and in danger of rupturing into the mouth or of burrowing down the neck, it is better to **open it from the outside of the neck**. Unless the abscess points elsewhere, it can be well approached by an **incision** behind the sternomastoid, **blunt dissection**, pushing aside the muscles of the neck. After the abscess has been thoroughly **evacuated** any **carious bone** that can be reached should be **removed** and the **cavity packed**.

In case the abscess presses on the spinal cord and causes paralysis, a question of operation for the relief of pressure comes in; but this is of very doubtful value. The pressure on the cord will probably diminish in a few months' time, restoration of function therefore taking place. If the laminae were to be removed for the purpose of exposing the abscess, there would be nothing left to support the spine. Operating on these abscesses is altogether different from removal of the laminae in cases of fracture, and should not be undertaken until time has shown all chance of improvement in other ways to be improbable.

Very exceptionally, paraplegia in spinal tuberculosis is caused by the *narrowing of the spinal canal in consequence of the collapse of the bodies*

of the vertebrae. In these cases **laminectomy** is advisable. All cases of laminectomy should have the spine supported and protected by a **plaster-of-Paris corset** for months, just as if the operation had not been done.

The technique of laminectomy is discussed under *Fractures of the Spine* (this article).

Forcible reduction of the deformity was revived by Calot, but the results very soon proved disastrous. The patient is anesthetized, placed face downward on a firm table, and traction made on the head and feet either by assistants or by compound pulleys. Pressure is then made on the prominent boss until the spine is forced straight. The patient is then enveloped in a plaster-of-Paris jacket, which extends upward so as to include the neck and head. A number of cases of sudden death and more of death following soon after the operation have been reported. There is danger of rupturing abscesses or of re-exciting inflammation by tearing apart old adhesions. That nature can fill the resulting large gaps between the vertebral bodies with new bone has still to be shown, and time will be necessary before this method can be approved except in unusual cases. Gradual reduction by suspension or by horizontal traction supplemented by backward bending of the spine without the use of an anesthetic is more feasible and, whichever method is adopted, the spine must be held in the corrected position until it can be so maintained by the patient, *i.e.*, until the disease is cured, sometimes a matter of years.

Hibbs's Operation.—This aims to ankylose the posterior part of the diseased vertebrae with each other and

with the healthy skin above and below. A longitudinal incision is made directly over the spinous processes through skin, supraspinous ligament, and periosteum, to the tips of the spinous processes. The periosteum is split over both the upper and lower borders of the spinous processes and the laminae and stripped back from them to the base of the transverse processes. The spinous processes are then transposed after partial traction so that they make contact with fresh bone, the base of each with its own base and the tips with the base of the next below. The adjacent edges of the laminae being absolutely free from periosteum, a small piece of bone is elevated from the edges of the laminae and placed across the space between them, its free end in contact with the base bone of the lamina next below it. The lateral walls of periosteum and the split supraspinous ligament are brought together over these processes by interrupted chromic catgut sutures. The skin wound is closed by silk and a steel brace applied with the space between the uprights increased somewhat at the site of the wound so as not to make pressure on it. **Rest in bed** is absolute from four to eight weeks. During the next four weeks sitting up in bed is permitted. At the end of the twelfth week walking is allowed. The **brace** is continued for another month, when it is removed for a part of each day, then gradually left off entirely. In children under 5 it should be worn six months.

Albee's Bone Grafts.—Albee has tried to cut short the time of treatment by transplanting a graft of bone secured from the crest of the tibia and long enough to go from the sound

vertebra above to the sound vertebra below the point of disease. It is important that this bone splint should include periosteum and bone-marrow, and be thick enough to stand some strain. An incision is made to one side of the spine and a skin-flap of sufficient size to include a couple of vertebrae above and below the diseased area turned back. Either spinal process is then split longitudinally for about one inch from its tip and on one side, but so as to fracture it, leaving a gap between the two pieces. The bone-graft is then taken from the shin, preferably by a circular saw operated by electricity and devised by Albee, inserted into the splits, and held by kangaroo tendon or chromic gut. If the kyphos is so marked that the graft cannot be bent, it is partly cut by the saw at several places on its lower border and then bent. The skin wound is then closed. After operation Albee advises **long recumbency on a convex gaspise frame**, so as to hold the correction.

In properly selected cases both these operations are of undoubted value, but a warning must be given not to expect to change the time of treatment of bone tuberculosis from three years to three months and to operate in every case.

In 33 cases of tuberculosis operated at the Mayo clinic by the **Albee method** and 6 by the **Hibbs method**, the patients on the whole did very well. The operation, while of great value, should be considered only an aid to treatment. All the patients had been requested to wear the brace one year after cessation of all symptoms, and all hygienic measures for tuberculous subjects were carried out. But 2 are going without braces; 1 is cured and the other much improved. **Most of those examined after 1 year**

do not show absolute fixation on flexion of the spine. But all show lack of muscular spasm and are nearly well. Henderson (St. Paul Med. Jour., Oct., 1914).

Success of bone transplantation by **Albee's operation** depends on the proper implantation of the bone splint. Essential is a careful protective after-treatment. Even a period of six months is much shorter than the average duration under non-operative methods. Jacobs (Jour. Amer. Med. Assoc., Jan. 30, 1915).

SCOLIOSIS, OR ROTARY LATERAL CURVATURE.

This is a most insidious disease, which offers some of the most difficult problems of orthopedic surgery.

ETIOLOGY.—The age at which it appears is usually said to be between 12 and 14, but in most instances the deformity begins in very early life, though on account of the absence of pain it is not detected until well-marked bone changes have taken place. In early adolescent life, moreover, deformities that have remained quiescent for several years quickly assume marked proportions due to the rapid increase in stature. Coincident with this may be "adolescent rickets," a disease well recognized on the continent of Europe. The softened condition of the bones then present is responsible, in my opinion, for the rapid progress made by some lateral curvatures. Some observers record instances of lateral curvature noticed at birth. The writer has since then seen such cases, all of which have been complicated by anomalies in the development of the skeleton.

The next most frequent cause of scoliosis is anterior poliomyelitis, and many such cases are unrecognized

because the extremities have recovered so as not to be noticeably deficient. In some cases of anterior poliomyelitis certain trunk-muscles have been damaged to such an extent as to impair the equilibrium between the two halves of the body, and so constitute a constant force working steadily toward the distortion of the thorax, which is only overcome with the utmost difficulty.

In some cases scoliosis arises after a severe pneumonia, usually with pleurisy, especially if purulent, the restriction of the movements of the thorax on the affected side being responsible. A number of cases under observation have convinced the writer that the German view, that rotation of the spine fails to accompany this variety of scoliosis, is erroneous.

Inequality in the length of the legs, owing to fracture, congenital dislocation, hip disease, and so forth, at times produces a scoliosis, but, unless the leg shortening is due to a paralysis, such scoliosis can usually be almost entirely removed by means of a thick sole on the patient's shoe.

In very rare instances scoliosis follows traumatism, as in one of my cases, where a difficult delivery following a transverse presentation caused separation of the ribs from the sternum, and later on in life a most exaggerated rotary lateral curvature.

Sometimes scoliosis which progresses rapidly during adolescence is caused by ovarian neuralgia, which sets up reflex contraction of muscles causing a deformity that rapidly subsides on relief of the pain. In rare cases hysterical contractions may produce a deformity closely resembling scoliosis.

There is a class of scoliotics in which, apparently, none of these etiological conditions is present. But the number of such cases grows smaller the more closely we study them, and it is my opinion that rickets or some central nervous lesion, analogous to anterior poliomyelitis, is the true cause of these "idiopathic" cases.

Congenital Scoliosis.—The writer divides such defects into 5 classes: 1. Developmental hindrances such as diminished amniotic fluid, the interpressure of twins, etc. 2. Skeletal malformations, such as *spina bifida*, and those due to defective development or union of the three pulmonary elements of which each half of the symmetrical bilateral trunk is constituted. 3. Variations from the normal, such as cervical ribs, defective development of the lower lumbar vertebra and sacrum. 4. Bilateral asymmetry of congenital origin. 5. Defects due to improper secondary development, the fetal chest and its high sternum; perpendicular ribs; chicken breast, etc. All these fundamental defects tend to develop or augment as growth proceeds. Böhm (Berliner klin. Woch., Oct. 20, 1913).

Diagnosis.—In no disease is early diagnosis more important than in scoliosis. The clothing should be removed as far as the great trochanters, the skirts being pinned round the hips. Time should be allowed to elapse for the patient to become accustomed to her strange surroundings, as, at first, she may hold herself more erect than usual. In the vast majority of cases the dorsal convexity is right-sided. Normally a plumb line from the nape of the neck should pass midway between the scapulæ and through the intergluteal fold, striking the floor midway between the feet. If there is any deviation

from this line, the patient's attitude is not correct. In the ordinary scoliosis the right scapula is farther from the median line than the left, the right hand hangs farther away from the hips than the left, and there is a larger space between the right elbow and the waist than on the opposite side. Quite often the shoulder on the side of the dorsal concavity is found lowered. The hips very often show an apparent difference in height, the hip on the side of the concavity appearing to be decidedly the higher. This difference is usually only apparent, and due to the sharp deviation of the trunk from the midline. Inspection from the front will often show the inequality of the hips to a greater extent than when viewed from the back. The breast on the side of dorsal convexity is almost always smaller than its fellow. There is also, usually, a difference in their distance from the umbilicus, the one on the side of the dorsal convexity being higher up. Many cases show a flattening of the plantar arch, and, at times, have very pronounced flat-foot. This calls for treatment, as it is impossible to preserve an erect carriage of the trunk if the feet upon which it rests are not in good condition.

The patient should now bend forward, keeping the legs straight, and letting the hands hang. In this position the ribs are better exposed to view than when the patient is upright, and small amounts of rotation of the spine can thus be made out.

Lateral deviation may occur in Pott's disease, and at times the deformity so closely resembles a true scoliosis as to deceive even those of large experience. Muscular spasm,

with pain on movement or with elevation of temperature, should cause a provisional diagnosis of spinal tuberculosis. **Rest and protection of the spine** should be tried and **gymnastics prohibited**.



Lateral curvature of spine, with marked rotation. (R. H. Sayre.)

Records should be kept of the condition of the patient to judge of the progress of a case. The age, weight, height, circumference of the chest, and length of the limbs certainly should be noted. A photograph also should be taken with both front and

rear views and, at times, a profile. With the patient lying prone upon the floor or some hard surface, the contour of the back should be taken at various points, by means of a flexible lead tape, and the tracing transferred to a permanent record. In taking later tracings or photographs, one must reproduce as nearly as possible the original conditions. Otherwise there is great danger of the physician deceiving himself in regard to the progress of the case.

The apparatus of Beely, of Berlin, and the Zander machine for taking diagrams of the thorax are very useful methods of recording the results.

Pathology.—Probably the early changes are in the intervertebral disks, which become compressed on one side, and so destroy the erect spinal posture. Compensating curves occur in the opposite direction at those points of the spine remote from the original curvature, in order to restore, as far as possible, the equilibrium of the trunk. From the fact that the spinous processes are united by the interspinous ligaments, lateral flexion of the spine is always accompanied by more or less rotation of the vertebræ on themselves, and this is the most difficult factor with which we are called upon to deal.

In the more advanced cases of scoliosis the deformity involves the entire vertebræ. The bodies of the vertebræ show unequal development of their two component halves, and the spinous processes bend to one side or the other, according to the curve. The bodies are often wedge-shaped, one side being twice the height of the other, and not infrequently large osteophytes are thrown out which at times firmly join several

vertebræ together, producing an ankylosis or encroaching on the intervertebral foramina, causing painful neuralgias.

In these cases the ribs also participate, their angles on the side of the convexity being accentuated, while the ribs themselves often droop so far toward the pelvis as to pass inside of its brim. The ribs may occasionally overlap each other, giving rise to great pain, and even to periostitis.

Not infrequently these bone changes extend to the pelvis itself, and in many cases the typical rachitic pelvis is readily distinguished.

The rotation of the front part of the body of the vertebræ is toward the side on which the convexity exists, and may be so great that a line through the spine and body of a cervical vertebra may be parallel with one through the fifth lumbar, and yet at right angles to one through the middorsal region.

Skiagraphs of the spine are now often taken in incipient scoliosis, and many skeletal anomalies have thus been discovered, which often are the real fundamental cause of the deformity, by throwing the body slightly out of balance early in life.

Treatment.—This consists, first, in removing any defect which predisposes toward a scoliosis. If the case be one due to paralysis, and the patient is unable to hold the body upright, artificial means must be employed to maintain it in an erect position. The same is true in some rachitic cases. The most important point in treatment is to detect the lateral curvature very early and to prevent bony deformity, rather than to remove the latter after it has become marked.

If the patient is *distorted to any appreciable extent*, force must be used to press the bones back toward the straight line as far as possible. In doing this, both **longitudinal traction** and **rotation** are necessary. The



Lateral curvature of spine, with marked rotation. (R. H. Sayre.)

most convenient method of employing longitudinal traction is for the patient to suspend herself partially by means of a head-collar fastened to a cross-bar and hanging from a beam by a compound pulley, the end of the pulley-rope being held by the patient,

who, keeping her arms extended to their fullest extent, lifts herself by degrees, hand over hand, until her heels are clear of the floor, thus suspending almost the entire weight of the body on her head and arms. The



Palm of hand against projecting ribs and hand of hollow side across top of head. Endeavors to bulge out hollow side. (*R. H. Sayre.*)

hips should now be grasped, either in a clamp or between the surgeon's knees, and the trunk twisted around its longitudinal axis, so as to reduce the deformity. In some cases the patient is laid prone on a firm couch.

The surgeon then presses with great force on the projecting ribs, endeavoring to force them toward the normal. The pressure is directed so as to rotate the vertebrae around the longitudinal axis in the proper direction, mere lateral pressure against the side tending to increase rather than decrease the angular rib deformity.

If the patient bends forward, placing the hands on the knees as if playing leap-frog, it will be found that the hollow side can be straightened by these voluntary efforts of the patient. These efforts, however, last but a minute fraction of the day.

Abbott's Method.—Abbott, of Portland, Me., has taken advantage of the increased mobility of the spinal column when in this flexed position to apply constant force by means of a plaster-of-Paris jacket.

The patient is placed in a position of marked flexion, and by means of bandages passing around the trunk the thorax is untwisted as far as possible, and the plaster-of-Paris jacket applied in this position. Thick felt pads are applied outside the skin-fitting shirt, at all points liable to have undue pressure exerted on them, and when the jacket is hard a window is cut out over the concave ribs. Another slit is then cut in front and pads pulled between the jacket and the patient, so as to make still more pressure on the front of the thorax. The patient's efforts at respiration thus cause the hollow ribs to bulge out through the window cut in the jacket, and his efforts to get away from the pressure in the front tend to rotate the spine on its long axis all the day long instead of during the few minutes devoted to exercise by the former method.

Abbott applies his jacket with the patient suspended, back down, in a sort of hammock, the feet being fastened to a pulley high above the head and suspended from a frame. The arms are twisted so as to rotate the spine and untwist the curve. Others apply the jacket with the patient seated and bent forward with the hands holding the sides of an up-right frame. The principle is always

corrected, but overcorrected, and a deformity on the opposite side caused.

After this has taken place a **removable corset** should be made which the patient wears all the time, removing it morning and night for the purpose of exercising. Later on, the corset may be removed at night.

A case is not cured until the patient can voluntarily hold the spine straight



Method of making pressure on projecting ribs to correct rotation in lateral curvature of the spine. (R. H. Sayre.)

to secure marked flexion of the spine, and in this position seek to unrotate the vertebrae, making pressure against projecting points and cutting windows through which the concave ribs may project in response to pressure from within the thorax.

Such a **corrective jacket** should be renewed in six weeks, the padding being changed once or twice a week, according to the amount of change.

Efforts are made to untwist the spine until the deformity is not only

without support, and until the twisted bones have become straight, as otherwise the spine will relapse when support is removed.

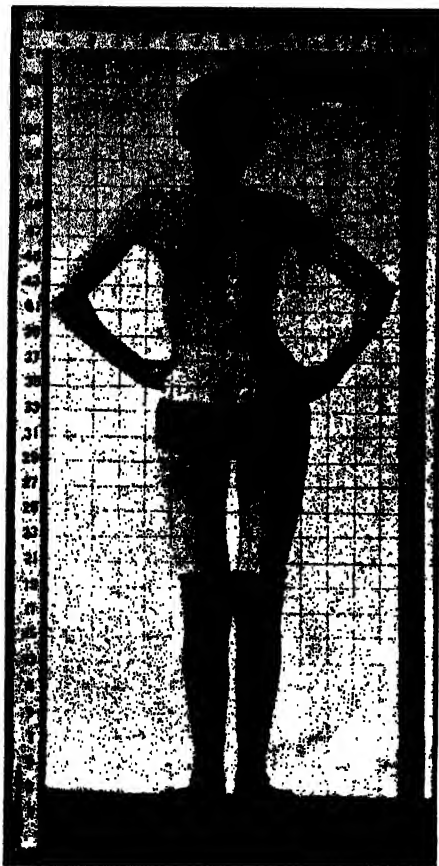
Report of Committee of the American Orthopedic Association to investigate the results of the treatment of scoliosis by the newer methods: 1. Overcorrection of the deformity is apparently possible by means of Abbott's method in cases of moderate severity and perhaps occasionally in severe cases. 2. If sufficient overcorrection is not secured or is not maintained long enough, partial or com-

plete relapse usually follows rather rapidly. 3. The period of retention in overcorrection necessary for a cure is longer than formerly claimed. 4. Abbott's method has apparently given better results in his own hands than in others. Freiberg, Silver, and

tracts from other endocrine glands. Properly fitted **braces** should be used, and supplemented by exaggerated **body flexion** over a curved frame and **rotary traction**. Peckham (Jour. Am. Med. Assoc., Oct. 13, 1917).

In ordinary cases, where a plaster jacket is necessary, it is most readily applied in the upright position.

In applying **plaster-of-Paris bandages** in cases of *lateral curvature*, a shirt of double length is used, pads are placed inside the shirt over the *mammæ* and outside the shirt over the *iliac crests*, and a strip of tin two inches wide is placed next the skin from sternum to pubes, on which to cut the plaster; the patient suspends herself, pulling on the free end of the rope which passes from the head-swing over the pulley, while she keeps the arms outstretched, the upper hand being on the concave side. The surgeon, sitting behind, applies bandages as in Pott's disease. When the plaster is set, which should be the case by the time the corset is finished, it is split open down the front and removed while the patient is still suspended. A thin slice is then taken from each edge of the slit and the corset held together with a roller bandage and dried. When dry, the next day, it is put on the patient while again self-suspended, and fastened with a roller bandage; then trimmed out under the arms and above the thighs until comfortable, and removed. The extra length of shirt is then reversed over the jacket and sewed to itself, covering in all the plaster, and lacings are sewed on in front. The latter are sewed through and through the plaster of Paris, a shoemaker's awl being used to make the holes. If the patient is very heavy it is well to reinforce the edges



Standing, hands on hips, patient endeavors to bulge out the hollow side and simultaneously to untwist the rotation. (R. H. Sayre.)

Osgood (Trans. Amer. Orthop. Assoc., 1913).

Since many cases of scoliosis occur in persons distinctly rachitic or showing symptoms of hypothyroidism, **thyroid extract** was tried, with pronounced success. It may be used also in other cases, and likewise ex-

of the corset under the leather which holds the hooks.

Plaster-of-Paris jackets should not be covered with shellac or varnish, as it renders them impervious and makes them hot and unhealthy.

If the case is very badly deformed, it is expedient to put padding inside of the shirt when it is reversed, in order to make the corset as symmetrical as possible, and thus avoid the necessity of padding the clothes.

The corset having been made while the patient is stretched out, it should always be applied to the patient in this position. For this purpose, the patient is provided with a pulley-wheel and head-swing at home, by which she can suspend herself in the morning, while the corset is applied by some member of the family, and retained in position by lacings joining the hooks on the front of the jacket. The lacing should pass first around the two central hooks at the waist, and then run down to the bottom, be reversed, and pass up again to the top. It is a mistake to cut a corset down in two places; neither should it be made so stiff as to be unremovable unless thus cut.

If support is to be used, a **plaster-of-Paris jacket** is the most useful, in my experience. The various forms of elastic supporting braces fail to accomplish their purpose.

If a patient requires a permanent support on account of *very marked deformity, or paralysis*, a **wood jacket** is lighter, though hotter, than one made of plaster of Paris. The **wire corset** is cooler than the wood, but not so light, and both require much more time and trouble to make. The same is also true of the **aluminum corset**, while **celluloid** forms a very

pretty support, but one so hot as rarely to be endured.

The key to success in all cases of lateral curvature, however, lies in developing the patient's own ability to hold the body in as improved a posi-



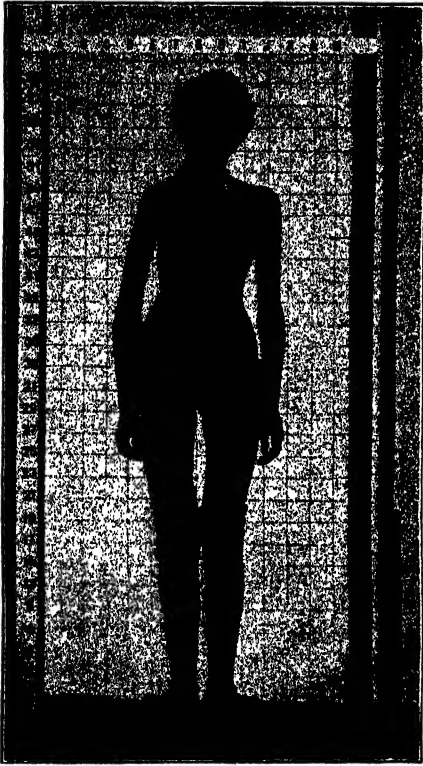
After forcible correction with plaster-of-Paris jacket and gymnastics. (R. H. Sayre.)

tion as possible. To be effective, exercise must be so carried on that the patient learns instinctively to help herself at all times during the twenty-four hours, and not merely to preserve an erect carriage while in the doctor's office. Any system which

fails to arouse the patient's desire to improve as far as possible by constant effort will fall short in its results.

The following set of **exercises** will be found useful for most cases:—

While **self-suspension**, in the man-



After forcible correction with plaster-of-Paris jacket and gymnastics. (R. H. Sayre.)

ner indicated, is a most useful procedure, it is not practicable for a long period of time; and it is wise to supplement it by **suspension** by means of a **weight and pulley** attached to a **chin-piece**, which is fastened to the patient's head while she lies on her back on an **inclined plane** which is **slightly convex**.

In correcting the rotation the pa-

tient should be placed **face downward** upon the floor or a firm table covered with a thick rug, while the physician makes strong pressure upon the projecting scapula, pushing in a direction forward and away from the central line of the body, so as to **rotate** the vertebræ toward the median line. In some cases the patient is allowed to lie for half an hour in this position with a sand-bag weighing twenty or thirty pounds resting upon the shoulder if it can be placed so that the weight is exerted properly.

In beginning the exercises a mat or thick shawl is laid on the floor and the patient lies prone, the arms at right angles with the trunk, palms down, face turned to the convex side, and the back as straight as possible. The patient supinates the hands, throws the scapulæ well back, raises the hands from the floor and lifts the trunk, while the surgeon holds the feet down. This is repeated three times; later on it can be done oftener. The patient should breathe naturally during the exercises. If necessary, to secure this make her count aloud.

With the hands behind the head, the patient raises the elbows from the floor, and raises the trunk as before, the feet being held by the surgeon.

With the hands behind the head and the elbows raised, the body is swayed toward the convex side, the patient trying to "pucker in" the bulging ribs and *not* to bend in the lumbar concavity. The feet are fixed.

With the arm on the side of the convexity under the body, the other arm over the head, the heels fixed, the patient raises the trunk from the floor.

Sometimes the arm on the side of the concavity is put on the opposite buttock, while the patient raises the

trunk. Sometimes the arm on the convex side is put on the buttock, and in cases of marked lordosis, with great stooping of the shoulders, both hands are put on the buttocks while the patient raises the trunk.

The patient now lies on the back, arms at the sides, palms up, and lifts first one foot in the air, while the surgeon makes resistance; repeated five times. The same is done with the other foot, and then with both. The feet are next separated and then brought together once more while the surgeon resists. Each leg then describes a circle, first from within out, then from without in.

If there is special weakness at the ankles, with a tendency to flat-foot, the patient flexes the foot and extends it against resistance, and turns the sole of the foot toward its neighbor, the surgeon resisting; and it is then forcibly everted again by the surgeon, the patient resisting.

The patient now lifts the arms from the sides, passing perpendicularly to the floor until they are stretched as far beyond the head as possible, and then, going at right angles to the trunk and parallel with the floor, returns them to the sides, palms up.

When the heels are held, the patient rises to the sitting position, hands at the sides; then she rises from the floor with the hands behind the head and the elbows at right angles to the trunk.

The patient now stands with the heels together, toes turned slightly out, hands behind the head, elbows at right angles to the trunk; then rises on tip-toe, bends the knees and hips, keeping the back as straight and erect as possible, and rises up once more. With the arm on the concave side

above the head, the arm on the convex side at right angles to the body, she rises on tip-toe, bends the hips, knees, and ankles, so as to squat, then rises and stands. All this time care must be taken to push the body as straight as possible, and gradually to educate the patient to hold it so without wriggling.

Let the patient practise walking in these positions, both on the flat-foot and tip-toe, and also stepping high, as if walking upstairs. With the palm of the patient's hand on the convex side against the ribs, pushing them in, the other hand on the concave side, she pushes a slight weight up in the air, while the body swings so as to straighten out the curves.

The surgeon should sit behind the patient, fix her thighs with his knees, while she holds both arms above the head and bows toward the floor, keeping her knees stiff while the surgeon keeps her ribs as straight as possible with his hands.

With the arm on the concave side across the top of the head, and the arm on the convex side around in front of the abdomen, the patient bends to the convex side through the ribs and *not* through the waist.

The patient sitting with the back toward the surgeon, the latter pushes one hand against the most projecting part of the convexity, and, with the other hand passed under the shoulder of the concave side, straightens out the curve as much as possible, the hand on the "bulge" acting as fulcrum.

The patient sits on a stool in front of the surgeon, who fixes the pelvis with his knees. The patient then twists the projecting shoulder to the front while the surgeon holds the el-

bows, which are at right angles to the trunk, the hands being behind the head, and makes resistance. In the same position the patient swings forward and back, swinging through the hips, keeping the back stiff and not bending in the waist.

The patient pushes in the ribs on the convex side with the hand, and pushes up with the hand on the concave side, the same as when standing. She also lifts the arm on the concave side up at right angles with the body while holding a weight.

In cases of round shoulders, wind-mill motions of both arms and to-and-fro movements of the head against resistance are advisable.

The patient lies prone on the couch, all the body above the waist projecting from it, while the surgeon holds the heels. With the hands behind the head, the elbows thrown back, the body is bent toward the floor, then raised up; later on, resistance is made by the surgeon. The patient lies on the concave side and rises up laterally. The patient lies with the convexity on the edge of the couch, and hands off as far and as long as possible.

The patient stands bent forward as if playing leap-frog, her hands on a chair, while the surgeon, with one hand under the shoulder on the convex side and one hand on the projecting ribs, corrects the rotation. It is advisable to steady the patient with the knee while doing this.

SPONDYLITIS DEFORMANS; BECHTEREW'S DISEASE.

This condition is an osteoarthritis of the spine, due to ankylosis of the vertebræ. It is due to osteophytic formations usually located on the

edges of the latter, but it may affect any part of the vertebræ and involve the heads of the ribs connected with them. It may occur at any age.

Symptoms.—It usually begins by tenderness of the spine, followed by severe and persistent pain due to inflammation and often to pressure upon the nerve-roots. This is followed, in most cases, by bending of the spinal column anteriorly, but the curvature may also be lateral and remain ankylosed in this position, the pain continuing if the nerve-roots are compressed. When the entire spine is involved, cervicodorsal kyphosis results, the head being projected forward and held in stiffly in that position and the lumbar spine being also rigid.

Treatment.—If recognized early this condition may be greatly benefited by treatment for ARTHRITIS DEFORMANS (see sixth volume, p. 109).

Personal case in a man of 46 years with ankylosis of the whole spine, both hips, the right knee, both shoulders and the right elbow. There are but 35 or 40 cases on record. They appear to be due to chronic infection.

Baths, electricity, and potassium iodide might be tried. Wenzel (Münch. med. Woch., May 12, 1914).

SPINAL LOCALIZATION.

It must be recollected that spinal nerves do not issue from the spinal canal directly opposite the segment from which they arise, but lower down, the distance below becoming greater the lower down the spine the injury is located.

We judge of the location of a cord injury first by the motor paralysis; second, by the cutaneous anesthesia; and, third, by the reflexes.

In the accompanying table from Keen are shown the various spinal

segments, the muscles innervated by each, and the part of the body supplied by sensation, as well as the reflexes (next page).

TUMORS OF THE SPINAL CORD.

These tumors may be *extradural* or *intradural*. There have been reported lipoma, osteoma, fibroma, sarcoma, myxoma, psammoma, carcinoma, tubercle, parasitic cysts, callus from old fracture, and connective-tissue formations. Gummata are usually capable of removal by constitutional treatment. Carcinoma is usually secondary and inoperable.

SYMPTOMS.—These vary with the location of the tumor; they are pain, motor paralysis, and sensory paralysis.

Pain is usually the earliest symptom and is often mistaken for rheumatism, but should be differentiated from this by not affecting various joints, and by its gradual onset. Muscular spasm is frequent, together with anesthesia on the side opposite the tumor, while hyperesthesia exists on the same side, with ataxia, motor paralysis, and exaggerated reflexes on account of the fact that the motor and sensory fibers of the cord cross at different levels. The pain is referred to a level below the tumor, and care should be taken to explore the cord higher up than the tumor was supposed to exist in case it is not discovered at this point. There is apt to be rigidity of the spine partly from pain and partly from muscle-spasm.

Paralysis may be caused by pressure simply or from myelitis, hemorrhage into the cord, or infiltration of the tumor, and is usually gradual in its onset. Motor paralysis progresses

from above downward, while the paralysis of sensation begins at the feet and ascends. The reflexes are exaggerated at the outset and diminish later on. Retention and incontinence of urine occur, with cystitis, rectal paralysis, bed-sores, and the usual chain of cord symptoms.

DIAGNOSIS.—This is based on cord involvement with the exclusion of other cord diseases, the site being diagnosed by means of the symptoms exhibited by various parts of the body, keeping always in mind the possibility of the tumor being multiple.

TREATMENT.—Except in the case of gummata, the prognosis is fatal without **operation**, and the latter should therefore be undertaken unless the condition of the patient is such as to render it hopeless.

SACROCOCCYGEAL AND SACROANAL TUMORS.

This region is occasionally the seat of dermoids; but these growths may also form between the sacrum and the rectum. Again, the cutaneous structures sometimes fail to coalesce in the sacral or coccygeal region and a *post-anal dimple* or *sinus*, the latter lined with skin and sometimes glands and hairs, is formed. Such a sinus may suppurate or become blocked up and form a dermoid cyst. The sacrococcygeal region may also be the seat of hydatid cysts, lipomata, and teratomata. Cysts, both unilocular and multilocular, may also develop between the sacrum and the rectum from remnants of the post-anal gut and neurenteric canal. They are readily detected by digital palpation.

Treatment.—Sacrococcygeal dermoids, lipomata, and hydatids should be extirpated; teratomata likewise if

LOCALIZATION OF THE FUNCTIONS OF THE SEGMENTS OF THE SPINAL CORD. (KEEN.)

SEGMENT.	MUSCLES.	REFLEX.	SENSATION.
Second and third Cervical.	Sternomastoid. Trapezius. Scaleni and neck. Diaphragm.	<i>Hypochondrium?</i> (third to fourth cervical). Sudden inspiration produced by sudden pressure beneath the lower border of ribs.	Back of neck and of head to vertex. (Occipitalis major and minor, auricularis magnus, superficialis colli, and supraclavicular.)
Fourth Cervical.	Diaphragm. Deltoid. Biceps. Coracobrachialis. Supinator longus. Rhomboid. Supraspinatus and infraspinatus.	<i>Pupillary</i> (fourth cervical to second dorsal). Dilatation of the pupil produced by irritation of the neck.	Neck. Shoulder, anterior surface. Outer arm. (Supraclavicular circumflex, musculocutaneous, or external cutaneous.)
Fifth Cervical.	Deltoid. Biceps. Coracobrachialis. Brachialis anticus. Supinator longus. Supinator brevis. Deep muscles of shoulder-blade. Rhomboid. Teres minor. Pectoralis (clavicular part). Serratus magnus.	<i>Scapular</i> (fifth cervical to first dorsal). Irritation of skin over the scapula produces contraction of scapular muscles. <i>Supinator longus</i> (fourth to fifth cervical). Tapping the tendon of the supinator longus produces flexion of forearm.	Back of shoulder and arm. Outer side of arm and forearm to wrist. (Supraclavicular circumflex, musculocutaneous, or external cutaneous, internal cutaneous, radial.)
Sixth Cervical.	Biceps. Brachialis anticus. Subscapular. Pectoralis (clavicular part). Serratus magnus. Triceps. Extensors of wrist and fingers. Pronators.	<i>Triceps</i> (sixth to seventh cervical). Tapping elbow-tendon produces extension of forearm. <i>Posterior wrist</i> (sixth to eighth cervical). Tapping tendons causes extension of hand.	Outer side and front of forearm. Back of hand, radial distribution. (Chiefly musculocutaneous, or external cutaneous, internal cutaneous.)
Seventh Cervical.	Triceps (long head). Extensors of wrist and fingers. Pronators of wrist. Flexors of wrist. Subscapular. Pectoralis (costal part). Serratus magnus. Latissimus dorsi. Teres major.	<i>Anterior wrist</i> (seventh to eighth cervical). Tapping anterior tendon causes flexion of hand. <i>Palmar</i> (seventh cervical to first dorsal). Stroking palm causes closure of fingers.	Radial distribution in hand. Median distribution in palm, thumb, index, and one-half middle finger. (Musculocutaneous, or external cutaneous, internal cutaneous, radial, median.)
Eighth Cervical.	Triceps (long head). Flexors of wrist and fingers. Intrinsic hand-muscles.		Ulnar area of hand, back, and palm. Inner border of forearm. (Internal cutaneous, ulnar.)
First Dorsal.	Extensors of thumb. Intrinsic hand-muscles. Thenar and hypothenar muscles.		Chiefly inner side of forearm and arm to near axilla. (Chiefly internal cutaneous and nerve of Wrisberg or lesser internal cutaneous.)

LOCALIZATION OF THE FUNCTIONS OF THE SEGMENTS OF THE SPINAL CORD. (Concluded.)

SEGMENT.	MUSCLES.	REFLEX.	SENSATION.
Second Dorsal. {			Inner side of arm near and in axilla. (Intercostohumeral.)
Second to twelfth Dorsal. {	Muscles of back and abdomen. Erectores spine.	<i>Epigastric</i> (fourth to seventh dorsal). Tickling mammary region causes retraction of the epigastrium. <i>Abdominal</i> (seventh to eleventh dorsal). Stroking side of abdomen causes retraction of belly.	Skin of chest and abdomen in bands running around and downward, corresponding to spinal nerves upper gluteal region. (Intercostals and dorsal posterior nerves.)
First Lumbar. {	Ilio-psoas. Rectus. Sartorius.	<i>Cremasteric</i> (first to third lumbar). Stroking inner side of thigh causes retraction of testicle.	Skin over groin and front of scrotum. (Iliohypogastric, ilioinguinal.)
Second Lumbar. {	Ilio-psoas. Sartorius. Quadriceps femoris.		Outer side of thigh. (Genitocrural, external cutaneous.)
Third Lumbar. {	Quadriceps femoris. Anterior part of biceps. Inward rotators of thigh. Abductors of thigh.	<i>Patellar</i> (third to fourth lumbar). Striking patellar tendon causes extension of leg.	Front of thigh. (Middle cutaneous, internal cutaneous, long saphenous, obturator.)
Fourth Lumbar. {	Abductors of thigh. Adductors of thigh. Flexors of knee. Tibialis anticus. Peroneus longus.	<i>Gluteal</i> (fourth to fifth lumbar). Stroking buttock causes dimpling in fold of buttock.	Inner side of thigh, leg, and foot. (Internal cutaneous, long saphenous, obturator.)
Fifth Lumbar. {	Outward rotators of thigh. Flexors of knee. Flexors of ankle. Peronei. Extensors of toes.	<i>Achilles tendon</i> (fifth lumbar to first sacral). Overextension causes rapid flexion of ankle, called ankle-clonus.	Back and outer side of leg; dorsum of foot. (External popliteal, external saphenous, musculocutaneous, plantar.)
First and second Sacral. {	Flexors of ankle. Extensors of ankle. Long flexor of toes. Intrinsic foot-muscles.	<i>Plantar</i> (fifth lumbar to second sacral). Tickling sole of foot causes flexion of toes and retraction of leg.	Back and outer side of leg, sole, dorsum of foot. (Same as fifth lumbar.)
Third, fourth, and fifth Sacral. {	Gluteus maximus. Perineal. Muscles of bladder, rectum, and external genitals.	Vesical centers. Anal centers.	Back of thighs, anus, perineum, external genitals. (Small sciatic, pudic, inferior hemorrhoidal, inferior pudic.)
Fifth Sacral and Coccygeal. {	Coccygeus muscle.		Skin about the anus and coccyx. (Coccygeal.)

possible. A postanal dimple should only be removed if it causes trouble. Some anosacral cysts can be removed through the rectal wall, but others require a preliminary osteoplastic resection of a portion of the sacrum.

CONGENITAL DEFORMITIES OF THE SPINE.

MYELOCELE OR RACHISCHISIS.—Myelocele is the result of deficient formation of the vertebral arches. The medullary plates fail to coalesce and the cord is rudimentary. The central canal not having formed, the endothelium which should line it is exposed. Only a part of the cord may be involved—partial rachischisis. These subjects are either stillborn or die a few days after birth.

SPINA BIFIDA.—Spina bifida is a congenital malformation of the spine analogous to and often associated with harelip, cleft palate, and bifid uvula, which is due to defective development of the ovum. A vertebra develops from four primary centers: two for the body, which made their appearance at the eighth week, and one for each lamina, appearing at the sixth week. If the laminae fail to unite in the median line, the cord and its membranes may protrude, forming a tumor on the back. Very rarely there is failure of union of the two halves of the body of a vertebra, an interior spina bifida resulting.

The gap caused by the failure of the laminae to unite may be small and confined to one vertebra, or may involve almost the entire width of the laminae and extend the entire length of the spinal column.

Now and then there is a defect in one or more vertebræ without protrusion of the membranes or cord,

—*spina bifida occulta*,—with no tumor to be seen. The existence of this condition should be suspected in persons with congenital disturbances of function of the lower limbs, especially with imperfect sphincter control. If there is a hairy patch on the spine, the probabilities of a *spina bifida occulta* are much increased.

In the ordinary spina bifida the contents of the spinal canal form a tumor in the median line of the back which may vary in size from a hardly appreciable button to a mass as large as a foot-ball. At times there is a constricted base and pedicle; or, the tumor may lie flat on the back. This tumor may be covered with tough, thick skin; but usually from internal pressure it is changed to a thin, translucent envelope through which the contents of the sac are visible. The fluid filling the sac is the same in character as the cerebrospinal fluid. Often spina bifida is associated with hydrocephalus; upon pressure on the tumor a sense of fullness may be communicated to the fingers held against the anterior fontanelle. The child's head may also swell when it is laid down and the spinal tumor grow larger when the child is placed upright.

There are three recognized classes of spina bifida. If the cord membranes alone protrude, the tumor is called a *meningocoele*. Should both the membranes and the cord, with its appertaining nerves, protrude, we have a *meningomyelocele*. Should the central canal of the cord become distended with fluid and push before it both membranes and cord, we have a *syringomyelocele*, or a condition known as *syringomyelia*.

It is by no means easy to recognize

the kind of tumor present except in the rare cases where the sac is so thin that the outlines of the nerves can be made out. Failure to see these, however, by no means proves that they are absent; but if there is marked involvement of the sphincters, with paralysis and atrophy of the lower extremities, it is almost certain that the case is a meningo-myelocele.

Prognosis.—This varies. At times the tumor is small and the general condition good; at others there is a large defect, the tumor is enormous, the lower extremities are paralyzed, there is little or no sphincter control, and frequently intelligence is almost lacking. Some of these very bad cases fortunately die soon after birth.

Treatment.—If the tumor is small and covered by strong skin, it may in time diminish in size, and nothing be required but **protection from traumatism by a shield of metal or celluloid**. If the skin is thin, painting it frequently with **tannin collodion** serves to thicken and toughen it.

In case the child does not improve in the control of its muscles, or if the skin covering the sac grows so thin as to threaten rupture, operative interference should be tried. This may consist either in **aspirating the fluid and injecting something to cause contraction of the sac** or in **excising the sac and closing the gap** as well as possible.

In 1848 Brainard, of Chicago, reported a series of cases in which he had successfully injected a **watery solution of iodine and potassium iodide**. Later on Morton advocated the use of an injection less apt than either water or alcohol to permeate the cerebrospinal fluid and cause con-

vulsions, viz., **iodine**, gr. x (0.65 Gm.); **potassium iodide**, gr. xxx (2 Gm.); and **glycerin**, fʒj (30 c.c.). With an hypodermic needle passed through the healthy skin into the sac a half-dram (2 c.c.) or so of fluid is drawn off and an equal amount of the iodoglycerin fluid injected. Pressure is applied during the operation to prevent, if possible, the fluid from entering the spinal canal. The **puncture is then covered with collodion and cotton and gentle pressure made on the sac**. In a few days, if all symptoms of irritation have subsided, the injection may be repeated. Better results have apparently attended the injection of **Morton's fluid** than any other method of treatment. On the other hand, in consequence of greater familiarity with radical operation and knowledge of how to avoid supuration the recent statistics of **excision** show great improvement, and there is no question that in many cases this is the procedure to be preferred and in some the only possible one.

Technique of Excision of the Sac.—The child is placed with the head lower than the tumor to avoid the too sudden escape of cerebrospinal fluid. Incisions are made to include the skin covering the sac. If the latter have a small pedicle it may be ligated. If the sac have a wide base it should be opened and removed, enough of it being left to cover the opening without tension. If nerve-fibers on the inside of the sac can be separated from the sac with ease they should be so separated and returned to the spinal canal. If, however, they are too intimately adherent, no effort should be made to save them. After closing the membranes efforts should

but little opportunity for operative work. Where there is complete section of the cord the prognosis is absolutely unfavorable; partial cord injuries offer certain chances without operation. Lewandowsky (Berlin. klin. Woch., vol. li, p. 1929, 1914).

In traumatic cases, removal of depressed bone or metal will do nothing to restore the portion of cord destroyed. Operation should therefore not be undertaken until there is evidence that the lesion is incomplete, but when such evidence exists, it should not be delayed. Operations to repair an injured cord, either by suture or grafting, are inadvisable. Wide exposure is essential. With extradural lesion and an apparently normal dura and cord, if there is no septic extradural focus, it is better to examine the cord. In operating for root pains, a sufficient number of roots must be divided. A. J. Walton (Lancet, Feb. 15, 1919).

If a portion of the blade has been broken off and left imbedded in the tissues, it should be searched for and removed, provided it is causing irritation and can be removed with safety.

Meningomyelorrhaphy.—The effects of complete transverse destruction of the spinal cord by a projectile or otherwise may be mitigated by exposing the cord, removing the injured tissues by a transverse section of both segments and joining the latter by means of sutures passed through both cord and membranes. In a case reported by Stewart and Harte in which $\frac{3}{4}$ of an inch of cord was resected, life was saved and the cord recovered partly its functions. In a series of 43 cases, collected by Haynes, this operation reduced the mortality from $69\frac{1}{2}$ to $42\frac{1}{2}$ per cent.

SPRAIN AND DISLOCATION.

—The vertebral column may be sprained like any other joint. If se-

vere, a tearing off of small bundles of muscle may accompany the injury. Much more seriously is to be considered the injury that may simultaneously be inflicted upon the spinal contents.

Symptoms.—These depend upon the damage done. There may be an external hematoma, which may not show itself for several days. If there has been a spinal hemorrhage it may either be in connection with the membranes, either extradural or subdural, (hematorrhachis) or in the substance of the cord itself (hematomyelia).

If the hemorrhage is extradural it is less apt to cause paraplegia. Hemorrhage of either variety may be so extensive as to pass from one end of the cord to the other.

If the paraplegia does not come on for some hours and the line of anesthesia mounts higher rapidly, it is very probable that hemorrhage is the cause. Browning has suggested the use of an aspirator needle in the diagnosis.

Hematomyelia may constitute either a "destroying" or a "compressing" lesion. If the former, there will, of course, be permanent paralysis. If the latter, there will be paralysis and anesthesia, more or less complete, below the level of the injury, with retention of urine and feces, and probably priapism, which subside as the blood is absorbed.

If a diagnosis of *hematorrhachis* can be made out and no improvement occurs after a sufficient length of time has been given for the blood-clot to be absorbed, it would be good surgery to open the spine for the purpose of removing the compressing clot. Iodide of potassium internally is supposed to favor its absorption.

Certain symptoms so often follow railway injuries that the term *railway spine* has been used in describing them, and some have concluded that the prompt recovery that at times follows the awarding of damages by a jury is proof that the patient was feigning disease; but the same symptoms in many instances are found when no one is held responsible for the injury and the question of damages does not come into consideration.

In some of the cases in which death has followed the shock, an autopsy has failed to reveal any gross lesions of the brain or cord. In other cases hemorrhage is found, and in others still there is a traumatic neuritis.

Some of these cases are incapable of muscular exertion, and even have little control of the bladder, but when suspended and fitted with a snug **plaster-of-Paris corset** can do a fair amount of work. Many require **support for the spine** for years, though eventually able to dispense with it.

As with other sprains, the mistake is often made of regarding slight cases as of trivial importance. If recovery does not promptly take place in mild cases, the **spine** should be **protected by support until all pain has ceased**, or the patient may be left with a weak back for the balance of his life. The **plaster-of-Paris jacket** is the most effective apparatus. Anything which will **immobilize the parts**, and allow the trunk to move as a solid mass, will answer the purpose.

DISLOCATION OF A VERTEBRA is infrequent and usually is accompanied by fracture, more or less extensive. It is most often cervical, next lumbar, and very seldom dorsal.

The **diagnosis** is based on sudden

disability after trauma, with some departure from the ordinary shape of the spine. The surgeon's manipulations must be very guarded, as it is quite possible to injure the already compressed cord so severely that permanent paralysis will ensue. If possible, an X-ray apparatus should be used for an exact diagnosis, which is perfectly easy in the cervical and fairly so in the lumbar regions, while skiagraphs of the thorax are unsatisfactory, except in children or very thin adults. Large experience in the interpretation of normal skiagraphs is necessary to comprehend properly a pathological one.

Treatment.—Efforts should be made by **manipulation** to replace the dislocated vertebræ, and experience alone can guide the surgeon as to just how these manipulations should be made. In case pressure upon the cord is urgent enough to demand it, the **vertebra** should be **exposed**, by incision and the rongeur, to **effect reduction**. If **operative interference** becomes necessary, it should not be delayed, in order to minimize the duration of cord compression, and also to formulate a definite prognosis. If no damage has been done to the cord, if the patient be free from pain, and the deformity slight, it will be unwise to endeavor to replace the vertebræ, as not infrequently they become ankylosed in their new position, with comfort to the patient and safety to life, while efforts to restore them to their original situation may result disastrously.

Bed-sores.—These are among the most distressing results that follow damage of the cord. They differ from ordinary bed-sores, due to pressure by bony prominences. They

may form inside of twenty-four hours, and usually first make their appearance as erythematous patches. These then turn into blebs, which burn, leaving a raw sore, which sloughs very deeply, perhaps down to the bone. If one side only of the cord has been injured the bed-sores will form on the opposite side.

Treatment.—This consists in the removal of all pressure, keeping the skin absolutely clean, washing the surface with alcohol and alum several times a day, and, after being thoroughly dried, dusting it with lycopodium, talcum, or boric acid powder.

Retention of urine is another constant accompaniment of cord-lesions, from paralysis of the bladder. This is accompanied by incontinence of urine, and the patient lies in a pool of decomposing urine unless constant care is exercised to **keep him dry**.

Part of the urine being retained, it becomes decomposed and soon sets up disturbances in the kidney. If great care is not exercised to **keep all catheters scrupulously clean**, this is sure to follow from urine infection.

SACROILIAC DISEASE.—The diagnosis of this is based chiefly upon the position of the patient, who bends to the opposite side in order to relieve the affected joint, the weight being largely borne on the opposite leg. Difficulty in bending or twisting the body is frequently experienced, and pain extends down the thigh, in the course of the great sciatic nerve. Careful local examinations will show tenderness on pressure over the sacroiliac joint, and if the two ilia are pressed together, so as to crowd them against the sacrum, pain will be produced. The same pain may be produced by crowding the head of the

femur into the acetabulum, as pressure will thus be transferred to the hip-joint, but hip-joint disease can be excluded by the production of pain when the iliac crests are crowded together.

Fever is usually but slight: perhaps half a degree. The disease is likely to be mistaken for lumbago and sciatica, but the position as described above is typical.

In addition to inflammation, tuberculous or other, of the sacroiliac joint, this joint, and also the sacrolumbar joint, is subject to sprains which give rise to the same deformity as chronic inflammation, but which often arise suddenly and without fever. A skiagraph may show a change in the relations of the sacrum, ilium, and last lumbar vertebra, but to get a clear idea of the condition a stereoscopic skiagraph is essential.

In some cases the slipped bone can be replaced by **manipulation** without an **anesthetic**; in others, anesthesia is essential, and a **firm girdle** around the pelvis is then required to retain this position. **Adhesive plaster** passed around the pelvis below the iliac crest is best, but as it irritates the skin if worn a long time, recourse must generally be had to a **webbing belt with perineal straps**. A **large pad over the sacrum** is usually required in addition.

Treatment.—In tuberculosis, if the pain is extremely acute, the patient may be put to **bed**, with **traction** applied in the long axis of the thigh, and also at right angles to it, in order to relieve joint pressure. If the pain does not rapidly subside, the **actual cautery** should be applied, burning very deeply along the line of the joint. The **weight** of the patient in walking

should be borne on the sound leg, and an elevation of from four to six inches should be applied to this shoe, in order that the foot of the affected side may swing clear of the ground. The shoe of the affected side may have half a pound of lead, or more, according to the comfort of the patient, fastened to the sole, to produce traction on this joint.

If suppuration takes place, remove all tuberculous foci, being careful that no pockets remain inside of the pelvis to cause infection. The older writers assumed that suppuration in sacroiliac disease was necessarily fatal, but modern results prove this erroneous.

At times it is extremely difficult to differentiate between sacroiliac and sacrolumbar tuberculosis. In the latter the plaster-of-Paris jacket gives prompt relief, and in sacroiliac disease it is of general use if continued down the leg to the ankle as a spica.

DISORDERS OF THE COCCYX.

—The coccyx rarely suffers from disease, except as the result of a traumatism, when it may undergo necrosis and require removal.

Coccygodynia, so called, at times demands the removal of the coccyx, performed through a longitudinal incision over it. But the great majority of cases suffer because of some other disturbance, — either hemorrhoids, a misplaced uterus, or an exhausted nervous system, — and such cases must be very carefully excluded before the diagnosis of coccygodynia is made; otherwise, although the bone be removed, the pain will continue.

LAMINECTOMY.—Access to the spinal canal for the purpose of relieving pressure or for any other purpose is almost always obtained by

removal of the laminae of the vertebrae. The entire back should be prepared for operation with great care. If possible, the operating table should be provided with a hot-water plate or other means of keeping the patient warm to lessen the shock, which is often severe, and means should be at hand for subcutaneous injection of salt solution in addition to the ordinary stimulants. A large number of hemostatic forceps will be required.

In many cases the primary spinal condition has interfered more or less with the function of respiration, and, as the patient is of necessity placed prone or semiprone, the anesthetist must pay more than usual attention to the condition of the patient.

Many surgeons advise making a single median incision, long enough to include five or six vertebrae. The muscles are then retracted to such an extent as to uncover the laminae on one side. A short cutting knife should be used to free the muscles from the bone, for, if a dull instrument is used, the tissue is apt to be so badly lacerated that necrosis follows.

Hemorrhage is apt to be very profuse at this stage. The operator should, however, proceed rapidly to complete the incision and stop the bleeding by pressure of compresses wrung out in water as hot as can be borne by the hand. The wound should be tightly packed while the laminae on the other side of the spine are being exposed. The second wound is then packed and the bleeding checked in the first. Hydrogen dioxide at this stage is of use as an hemostatic. The interspinous ligament is cut through. In the dorsal region the incision must be made in a slanting direction, owing to the

overlapping of the upper over the lower vertebræ. With a rongeur or rib-cutter the laminae are then cut through and removed.

Some surgeons prefer making an **osteoplastic resection**, using an H or U incision. Some of them use Hey's saw or a chisel to divide the laminae. Care must be had to make the cut through the laminae at a sharp angle, otherwise it will not enter the spinal canal. The interspinous ligament of the vertebræ at the cross-cut is now divided, and the flap with the spinous processes and arches attached reflected upward and laterally, otherwise the spinous processes will meet and prevent lifting the flap.

A layer of adipose tissue is now met with; this should be divided in the median line and pushed aside, when the dura will be brought into view. Bleeding can be controlled by **pressure, hot water, and hydrogen dioxide**. The cord should pulsate. If it does not, the absence of pulsation may point to adhesions, swelling of the cord, or pressure by bone or fluid. If relief from bone-pressure is being sought, it often is not enough to remove the laminae, as the pressure may be caused by encroachment on the anterior surface of the spinal canal. To reach this the spinal cord may be drawn to one side by an aneurism needle or other blunt hook, the extremities of the patient's trunk being meanwhile supported on sand-bags, making the spine concave posteriorly, so as to relax tension on the cord. Should it be necessary to divide any nerve-roots in order to move the cord far enough to one side, these nerves should later be sutured.

If the dura is distended with blood, its color will be purplish; yellow, if

pus be present. A tumor can usually be recognized by touch.

If the trouble has not been satisfactorily remedied, the dura should now be opened. If a tumor be present, it should be removed if possible, but it may infiltrate the cord so as to be inoperable. **Blood-clots, fragments of bone, etc.**, should, of course, be removed when the cord is lacerated. Efforts to suture the cord have so far been disappointing. The **dura** should be **closed with fine sutures** unless for some reason pressure on the cord is not desired. The **skin incision** may or may not be **drained**, the dependent position of the cut favoring the escape of fluid. If a drainage-tube is employed, it should be removed in twenty-four hours. A **plaster-of-Paris bandage** outside all the dressings is advisable in almost all cases—certainly in those for Pott's disease and in fracture.

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SPINE, DISLOCATION OF.

See DISLOCATIONS.

SPIRILLOSIS. See RELAPSING

FEVER.

SPIRIT OF MINDERERUS.

See AMMONIUM.

SPLANCHNOPTOSIS. See INTESTINES: VISCEROPTOSIS.

SPLEEN, DISEASES OF.— FUNCTIONS OF THE SPLEEN.—

To establish the diseases of an organ on a satisfactory clinical basis its functions should be known. Unfortunately such is not the case with the spleen. Many functions have been attributed to it, but none can be said to have been clearly established.

At the present writing the following deductions seem warranted:—

1. The spleen is a contractile organ, the rhythmic systolic and diastolic movements of which are prolonged, the cycle lasting about one minute. This process is probably concerned with digestion since the organ begins to enlarge when this function begins and continues to do so five hours, when it gradually recedes, resuming its normal size in about seven hours.

[My own view in this connection is that in keeping with the experimental studies of Herzen, Lépine, Gachet, and Pachon, the spleen produces an internal secretion which converts the pancreatic trypsinogen into trypsin. The latter taking part in digestion and the defensive reactions of the body, we have an explanation of the next function attributed to the organ. S.]

2. It participates, through its internal secretion, in the defensive functions of the body against certain infections: anthrax (Bardach), *Trypanosoma brucei* (Bradford and Plummer), syphilis, etc., in common with other lymphatic glands. This function, however, is but an auxiliary one, judging from the comparatively harmless effects of splenectomy, and the fact that, after this operation, the general lymphatic glands take up its functions while new hemolymph-glands are being developed.

The functions of the spleen are to remove bacteria and certain toxic agents from the blood, to conserve the food values of the broken-down blood-corpuscles, and to send their remnants to the liver for utilization. The gland has no important internal secretion and is not essential to life. It is not an obsolete organ, however, as often suggested. W. J. Mayo (Jour. Amer. Med. Assoc., March 4, 1916).

[The prevailing impression that removal of spleen is comparatively harmless is based on the fact that splenectomy is performed in diseases in which the organ has undergone sufficient change to render it virtually functionless and after the general lymphatic system has assumed its functions. When, however, the operation is performed where the organ is normal, as, for instance, after rupture, marked constitutional disturbances may be encountered. Among these may be men-

tioned: Extreme anemia, emaciation, daily rise of temperature and increased frequency of pulse, attacks of fainting, headache, drowsiness, great thirst, severe gripping pains in the abdomen and pains in the arms and legs; marked enlargement of the lymphatic glands, which may be permanent; great diminution of the red blood-corpuscles, and considerable leucocytosis. S.]

3. It serves to break down worn-out red corpuscles by means of a ferment and to prepare the constituents and contents of these cells (globulin, hemoglobin, etc.) for physiological processes elsewhere, the pancreas, liver, blood, etc., including the elaboration of bile, hemoglobin, new corpuscles, etc. This probably applies also to worn-out leucocytes and particularly phagocytes.

There can be no question that in the spleen a large number of cells undergo their final disintegration after the action of hemolytic poisons, and that the hemoglobin there liberated passes by the portal system directly to the liver. When the spleen is removed, this disintegration occurs in other organs, notably, in the lymph-nodes and bone-marrow, and the hemoglobin from these organs passes not into the portal but into the general circulation, from which it reaches the liver more gradually and in a more dilute form. Austin and Pepper (Jour. Exper. Med., Dec., 1915).

Its functions are probably more important in childhood than after middle life, when it begins to atrophy as do the thymus, tonsils, etc., until old age, when it is reduced in normal subjects to a small, shrivelled, though vascular, remnant.

ANOMALIES.—The spleen may vary in size irrespective of any disease. Small spleens have been met which weighed less than one ounce, and congenital absence of the spleen has, though rarely, been noted. Large spleens are, as a rule, met in infants, but often in conjunction with some teratological defect. Accessory

spleens, spleniculi, are common, especially in the peritoneal folds about the hilum, but they may be widely scattered in the abdomen.

Malformations of the spleen are common. Its lower edge is often the seat of deep indentations. It may be rounded or elongated. Its anterior margin may present several notches, or a single deep one almost dividing the spleen into two parts. The notch may be near the lower end or even on the posterior border. Long processes may be given off from the main body. Occasionally the spleen is represented by a number of small masses scattered about the peritoneum or clustered into masses like bunches of grapes. They may become imbedded in the spleen itself. They are supposed to be more common in early life.

Malposition of the spleen is occasionally observed, the organ being located in other parts of the abdominal cavity, even on the right side, the liver being then transposed to the left side.

MOVABLE OR WANDERING SPLEEN.—This condition, also termed **floating spleen**, **dislocated spleen**, and **splenoptosis**, is uncommonly met with, and, in most instances, in women. It may be due to relaxation and elongation of the suspensory ligament which connects it with the diaphragm because of increased weight with or without enlargement of the organ itself, or to traction upon it by neighboring organs, the stomach, kidney, colon, pregnant uterus, etc. The condition may occur in conjunction with general enteroptosis and, though rarely, as a result of traumatism. Malaria, syphilis, and other diseases which

cause splenic enlargement may occur as etiological factors.

Symptoms.—These, as a rule, are slight and variable, as the organ may migrate into any part of the abdomen and be extremely mobile, especially in women who have borne several children. Often the symptoms consist of a dragging sensation on one side of the abdomen, with backache, recurrent headaches, digestive disorders, lassitude, and insomnia. Direct interference with neighboring organs through pressure may cause jaundice, ascites, intestinal obstruction; renal, uterine, and cystic disorders.

Torsion or twisting of the pedicle may bring on alarming phenomena quite suddenly if the torsion is complete. These may include sudden enlargement of the organ and severe local pain, marked pallor, with anemia, fever, uncontrollable vomiting, marked shock, and collapse. When the torsion is incomplete the symptoms are less acute. In some cases the torsion may lead to rupture of the supporting ligaments. The perisplenic tissues may become inflamed and cause considerable local pain.

The writer studied the records of 79 cases of torsion of a wandering spleen to which he adds 1 of his own, all in women. He knows of only 3 cases in men. In 13 cases the spleen was removed during a pregnancy or after delivery, and all the women recovered but 1, who died on the sixth day.

On the other hand, 4 of the 13 women died who required splenectomy for rupture or other injury of the spleen during a pregnancy. The greatest damage from a wandering spleen occurs when it is in direct contact with the genital organs and adhesions develop or it pushes them out of place. Montuoro (*Zeitschr. f. Geburts. u. Gynäkol.*, Aug. 23, 1913).

Diagnosis.—This, as a rule, is not difficult provided it is borne in mind that the organ may be found in any part of the abdomen, and that it sometimes becomes adherent to another organ. The misplaced spleen is usually close to the surface and its outline, with its sharp, indented edge and pulsating artery at the hilus, can usually be discerned by palpation. This, coupled with the absence of dullness where the organ should normally be, and the possibility of causing the displaced organ to glide back to this normal position, added to the general symptoms, usually establishes the diagnosis.

Case of dislocated spleen in a girl of 17 who entered the hospital with severe pain in the right lower abdomen and local symptoms suggesting an appendicular abscess with matting and adhesions of the omentum and bowel. Constitutional symptoms developing, the abdomen was opened and a huge, engorged, bleeding spleen was found. It was replaced in the normal situation. The conservative method in this case appears to have been right, for after thirteen months the organ had shrunk to half its original dimensions, was fixed, and situated midway between its normal position and the umbilicus. Blackburn (*Austral. Med. Gazette*, Dec., 1907).

The conditions for which it may be mistaken are **hydronephrosis**, **movable kidney** and **abdominal tumors**, particularly when these are sessile. In some cases, cystoscopic examination is required. **Extra-uterine pregnancy**, **ovarian** and **uterine tumors**, and **fecal accumulation** may also be simulated.

Treatment.—In mild cases, treatment of the causative disease, if any, and the use of suitable bandage after

replacement of the organ will often suffice. In severe cases, operative measures are indicated. **Splenectomy** is to be preferred to **splenoexy**. The former operation causes slight if any changes in the normal blood-picture, according to Fowler, and the mortality is low. Leukemia and marked disease of the organ preclude operative intervention.

Series of 9 cases in which a displaced spleen was removed on account of severe symptoms. In one of these, the patient, a woman aged 42 years, suffered from an enlarged spleen with a twisted pedicle. The organ on removal weighed 1200 grams. In another case, the spleen occupied the entire abdomen. It weighed on removal 2000 grams. The patient recovered. A still larger spleen was removed from a woman aged 30 years, the organ weighing 2200 grams. Recovery followed. The other patients were also women, aged 30, 45, 32, 20, and 25 years. Zhilinskaja (*Roussky Vrach*, July 11, 1915).

ACUTE HYPEREMIA or CONGESTIVE ENLARGEMENT OF THE SPLEEN.—This condition is also designated as **acute splenic tumor**. This term is misleading and should be dropped.

The condition occurs in acute toxemias of various kinds, particularly those attending typhoid and typhus fever, septicemia, pyemia, ulcerative endocarditis, glanders, anthrax, abortion due to sepsis, etc., and less frequently as a result of intoxication by drugs, the coal-tar derivatives in particular. Acute splenic hyperemia may also follow traumatism, or occur as a result of temporary pressure by adjoining swollen structures, or of obstruction by emboli. It may attend practically any infection, but not to a

sufficient degree to be recognized clinically. In yellow fever, for example, the spleen is said never to become enlarged, though probably hyperemic. The enlargement due to acute infections is usually moderate and tends to disappear with the cause of the toxemia. While in chronic enlargement of the spleen the organ is usually hard, in the acute form it remains soft and flabby.

SYMPTOMS.—These depend upon a great variety of conditions, causal and local, which may include displacement, torsion, abscess, rupture, embolism, perisplenitis, etc. Enlargement of the spleen and pain in the splenic region are leading symptoms, but the latter may be absent, though tenderness on pressure and a sensation of weight are usual. The splenic tumor may be accompanied by pulsation of the organ, sometimes so marked as to be discernible on inspection. This may occur in both the acute and chronic forms, especially when blood-pressure is high and there is a concomitant valvular disorder.

TREATMENT.—The causal factor naturally demands primary attention. The splenic congestion being usually attended with high blood-pressure, **hypodermoclysis** or in children **proctoclysis** may be tried, to reduce the viscosity of the blood by increasing its osmotic power. The **iodides** sometimes prove effective, whatever be the cause, in reducing splenic enlargement when it persists during convalescence. **Strapping** of the splenic region to prevent free motion of the organ, **dry or wet cupping** over it or applications of **cold compresses** tend to inhibit the hyperemia. **Purgation**, using **saline cathartics**, acts in the same direction.

ABSCESS OF THE SPLEEN or ACUTE SUPPURATIVE SPLENITIS.

—This condition may occur as a result of infection of the spleen by neighboring ulcerative processes, empyema, peritonitis, etc., but as a rule it is caused by septic emboli, such as those formed in, ulcerative pericarditis, pulmonary abscess, etc. It may occur also as a complication of splenic congestion in the course of typhoid, malarial and other infectious fevers. It has been attributed to cold, exhaustion, traumatism, etc., but these factors act by weakening the defensive reaction of the tissues. The size of the abscess varies from a small aggregate of pus to an enormous accumulation sufficient to suggest ascites. Those due to emboli, however, tend to be small.

When an abscess penetrates the capsule perisplenitis is developed, but the resulting adhesions may wall it off; if they fail to do so, however, and pus is evacuated into the abdominal cavity, fatal peritonitis develops. An embolic abscess is usually fatal while a non-embolic abscess may, if evacuated, end in recovery.

SYMPTOMS.—Pain in the splenic region, aggravated and extended when neighboring structures such as the pleura, diaphragm, etc., are involved; tenderness over the splenic area and the usual symptoms indicating a suppurative process—chills, fever, nausea, vomiting, prostration, more or less marked leucocytosis—constitute the picture usually obtained. Enlargement of the spleen may usually be detected, even if the abscess be small; if it is large fluctuation may sometimes be elicited, while the onset of a non-embolic abscess may be gradual and the symptoms develop pro-

gressively. In embolic abscess, however, the onset is sudden. Involvement of neighboring structures is common, and gives rise to dyspnea, cough, and expectoration of pus and blood, for instance, if the abscess open into the pleura and lung; pleuritic pain if the former alone be invaded, etc. The stomach, intestine, diaphragm, perisplenic tissues, and pancreas may be involved. The X-rays are sometimes helpful to locate the abscess and exploratory puncture is advocated by some, but this is at best a dangerous procedure owing to the danger of favoring rupture of the abscess.

The course of the case depends upon the nature of the causative disorder. If this be an ulcerative endocarditis, a pyemia, etc., and an embolus be the direct cause, the chances of recovery are at best very remote. This applies also to an abscess which causes pleurisy, peritonitis, nephritis, etc. If it open, however, into the stomach or intestinal canal, the possibility of recovery is greater, but prompt evacuation tends to insure it.

Case of primary abscess. The symptoms were low fever, headache and pain under the seventh rib, radiating to the shoulder. In the course of two months increasing fever and chills compelled intervention and rapid recovery followed resection of two ribs to permit evacuation of pus between the lobes of the lung, after evacuation of the pus in the spleen. Belloni and Moschini (Gazz. d. Osped. e. d. Clin., Feb. 1, 1910).

TREATMENT.—The condition of the patient and the nature of the disease warranting it, the abscess should be reached and evacuated. This is best done by **laparotomy** at the outer edge of the left rectus muscle. The

spleen is then sutured to the abdominal wall in such a way as to prevent carefully all access of fluids to the abdominal cavity. The abscess is then opened and drained. In some cases the spleen is found to be adherent to the wall. In extensive abscesses, or such as are not amenable to this procedure, **splenectomy** is indicated, having given a low mortality (G. B. Johnston). When operative procedures cannot be resorted to, **strapping** of the splenic area to limit movement and if possible the **iodides** to favor absorption may prove useful.

RUPTURE OF THE SPLEEN.

Although traumatism may cause rupture of the spleen, malarial disease of the organ is by far its most frequent cause. Then come in the order of frequency according to Berger's statistics (1902) pregnancy (usually where the spleen was already diseased), typhoid fever, leukemia, syphilis, alcoholic cirrhosis, tuberculosis, hemophilia, and capsular varices. To these have been added by other observers: typhus, anemia, eclampsia, relapsing fever, infarct, abscess, and aneurism. Splenomegaly does not always exist. It may occur spontaneously, but a strain, as in the course of an eclamptic paroxysm, causing traction on the capsule, through adhesions formed in the course of a concomitant perisplenitis, may also cause it. One or more ruptures may occur. The resulting hemorrhage is occasionally encapsulated by splenic adhesions, but, as a rule, the blood is liberated into the abdominal cavity, usually in large quantity.

SYMPTOMS.—Although unusual discomfort may precede the rupture, the first symptom is severe abdominal

pain, soon followed by symptoms of severe shock, pallor, faintness, coldness of the extremities, etc. If the hemorrhage be very severe, the patient may die within the hour. The acute symptoms may be deferred 3 or 4 days, but, as a rule, a febrile reaction with signs of peritonitis occurs, which soon ends in death. Muscular rigidity in the left hypochondriac region is an early symptom. Percussion over the spleen may indicate reduction owing to ischemic collapse. The accumulating blood-mass in the abdomen may also elicit dullness over an increasingly large area, which mass, as shown by Ballance, does not shift when the patient is moved. The history of the case, moreover, and the suddenness of the onset of shock and pain, point clearly to the nature of the complication.

TREATMENT.—Immediate laparotomy is indicated. The bleeding area should then be sought, compressing the pedicle if necessary to check the bleeding while this is being done. **Splenectomy** has given the best results (66 per cent. recoveries in 150 cases collected by G. B. Johnston). If, however, the tear is small and the organ is in good condition, the opening may be closed with a **catgut suture** and the suture line covered with omentum. **Forcipressure** by suitable forceps may be used to approximate torn edges, thus allowing them to be pared and sutured. Very small tears sometimes warrant the use of the **tampon**.

SPLENOMEGALY, OR CHRONIC ENLARGED SPLEEN.

That chronic enlargement of the spleen is but a symptom of many disorders is well shown by the following

list of causal factors published by Osler in 1908:—

1. In children, disturbances of metabolism and chronic intestinal infections: rickets, amyloid disease, and a large, ill-defined group of intestinal disorders, particularly in the tropics; the pseudoleukemia infantum.
2. Infections: syphilis, malaria, kala-azar, and other forms of tropical splenomegaly, Hodgkin's disease and tuberculosis.
3. Primary disorders of the blood-forming organs: leukemia, pernicious anemia, chlorosis, hemochromatosis; polycythemic splenomegaly.
4. Cirrhosis of the liver: syphilitic, alcoholic, hypertrophic of Hanot.
5. Hereditary and family forms of splenomegaly: (a) with congenital acholuric icterus; (b) with constitutional disturbances, dwarfing, etc.
6. New growths and parasites: sarcoma, primitive endothelioma of Gaucher, echinococcus, and the schistosoma of Japan.
7. Splenomegaly not correlated with any of the above or with any known cause: Banti's disease, with its three stages of (a) simple enlargement, (b) splenomegaly with anemia, (c) splenomegaly with anemia, jaundice and ascites.

In recent years, however, the tendency has been to individualize several syndromes out of the series, viz., splenic anemia, which includes Banti's disease as a terminal stage; Gaucher's splenomegaly, tropical febrile splenomegaly (kala-azar), and polycythemic splenomegaly. These disorders (excepting KALA-AZAR, already treated in vol. vi, page 174) are reviewed below. We shall consider, in the present connection, therefore, only splenic enlargements which occur in general disorders.

Syphilitic Splenomegaly.—Where, as in children, a history of lues is difficult to trace, Hutchinson teeth, interstitial keratitis, persistent cracks at the corners of the mouth and other familiar signs will serve, with a positive Wassermann, to establish the cause of the enlarged spleen. Al-

though, as a rule, the latter is not very large, in rare instances it fills the entire left side of the abdominal cavity. Stunted growth and infantilism are common in splenomegaly due to inherited syphilis. In acquired syphilis the splenic enlargement may be due to gummata, diffuse cirrhosis, or perisplenitis. Profound anemia may be present and the picture of splenic anemia (*q. v.*), with its hemorrhages, hepatic cirrhosis, etc., predominate. Syphilitic splenomegaly often complicates syphilitic cirrhosis of the liver. Leucopenia is usual in acquired syphilis, while in the inherited form the proportion of leucocytes is, as a rule, normal.

Tuberculous Splenomegaly.—The spleen may be the seat of primary tuberculosis. This is sometimes followed by general hyperplasia of the lymphatic tissues, being then often mistaken for a lymphadenoma. The course may be acute or chronic. There is a sensation of oppression and more or less pain or at least tenderness on the left side of the abdomen, and in sufficiently advanced cases respiratory disturbances, at times with cyanosis, fever with afternoon exacerbation and asthenia.

Gastrointestinal disturbances are common and sometimes indicate the simultaneous presence of tuberculous peritonitis.

The blood-picture is not characteristic. While the erythrocytes may be reduced in some, in others a distinct polycythemia may be present. The spleen shows tuberculous nodules and caseous masses with areas of fibrosis. Tuberculous splenomegaly not uncommonly complicates general tuberculosis, especially the miliary form.

In young children the spleen is especially active, and all general infections attack it; all pathologic conditions of the blood affect it more than other organs, and as it is such a vascular organ, any insufficiency in the circulation is felt most severely here. In the case of a much debilitated boy of 7, observed by the writer, an enormous enlargement of the spleen was traced by exclusion to either tuberculosis or inherited syphilis. Test treatment being resorted to, the swelling disappeared after the second injection of *neo-arsphenamin*, plus **X-ray** exposures of the spleen. Lesne (*Médecine*, Aug., 1920).

Malarial Splenomegaly (Ague Cake).—The spleen becomes acutely congested during a malarial paroxysm. While this enlargement subsides after each attack, repetition entails a disposition to the permanent form. At first soft and pulpy, the parenchyma finally becomes firm with prominent trabeculae. The pigmentation is sufficient in some specimens to constitute a true local melanosis. The intercommunicating lymphoid spaces and vessels may become obstructed with these products of broken-down hemoglobin, constituting veritable thrombi. The spleen may then attain immense size and even extend down to the ilium. Its weight may reach 10 pounds or more. Malarial splenomegaly is the most prolific cause of rupture of the organ, 93 of 132 cases being of malarial origin, with but 1 traceable to syphilis and 1 to tuberculosis. The history of the case and examination of the blood for the plasmodium remove diagnostic doubts.

Thrombotic Splenomegaly.—Enlargement of the spleen may also be caused by thrombosis of the splenic vein. This may be due to degen-

erative processes of the latter or its radicles, in the course of chronic degenerative diseases, pressure of diseased neighboring organs, tumors, traumatism, displacement of the spleen capable of causing torsion of the vein, etc. While at first passive congestion and localized hemorrhages may occur, fibrosis follows. Besides the splenic enlargement there are usually gastric and other hemorrhages, thus causing a syndrome resembling greatly that of splenic anemia (*q. v.*). The blood changes are less marked, however, and the general phenomena less acute.

The first sign of infarcts in 2 cases was a sudden excruciating pain in the region of the organ affected, strictly localized, not radiating, persisting for some time unmodified without essential remissions, but gradually subsiding in the course of a few days. An infarct in the spleen or kidney may occur with severe symptoms suggesting ileus or peritonitis, probably of reflex origin (collapse, vomiting, retention of feces and urine). These symptoms may be accompanied by slight temperature and possibly also by moderate leucocytosis. Head's zones of hyperalgesia on the skin are sometimes noted, and their location on the right or left side may sometimes have diagnostic importance to determine whether the left kidney or the spleen is affected. Enlargement of the spleen and friction in the splenic region point to this organ. Riebold (*Deut. Arch. f. klin. Med.*, Bd. lxxxiv, no. 5 u. 6, 1905).

Amyloid Spleen.—When amyloid occurs—as a result of tuberculosis, syphilis, chronic suppurative processes, especially those of the joints, or rarely from carcinoma, malaria, gout, alcoholism, etc.—it is only when the organ is greatly enlarged that the condition may be recognized. Its

edge, which may then be palpated, feels smooth but hard and, unlike virtually all other splenomegalies, is not sensitive to pressure. What pain is experienced is due to the weight of the organ and to perisplenitis. What anemia may be present may be due to interference with the hematopoietic functions of the organ, but in most instances it is due to the causative disorder. Rarely, primary amyloid spleen has been witnessed.

Miscellaneous Forms of Splenomegaly.—Besides the foregoing varieties of splenomegaly, others are occasionally encountered in which therapeutic measures often prove helpful.

To the various disorders of the blood, besides splenic anemia and polycythemia to which special sections are devoted below, the **spleno-medullary** or **myeloid** form of **leukemia** may be added. Such cases are characterized by very great enlargement of the spleen, the organ often reaching below and beyond the umbilicus. This causes abdominal discomfort and pain in the splenic area, often due to perisplenitis, and to adherence of the enlarged organ to various viscera, including the stomach. It is easily identified by the very marked leucocytosis and the other symptoms of leukemia. In **pseudo-leukemia** or **Hodgkin's disease**, the spleen is enlarged in a majority of cases, but not to the extent observed in leukemia. Hence the fact that the enlargement is seldom associated with pain. Repeated blood examinations here reveal a progressive secondary anemia. The enlargement of the lymph-glands serves to distinguish it from **pernicious anemia**, another blood disorder in which the spleen may be enlarged. Here, how-

ever, the condition is one of hyperplasia with exacerbation of hemolytic activity as illustrated by the beneficial effects of splenectomy, viz., a post-operative rise of the erythrocyte count. Here the characteristic variations in size and shape of these cells and the other signs of pernicious anemia will be found. Closely allied to this blood disorder is one recently described by Banti under the name of **hemolytic splenomegaly** in which hyperplasia of the organ also enhances its hemolytic activity, probably under the influence of some undetermined poison. It is characterized by a rapidly progressive anemia, jaundice without clay-colored stools, urobilinuria and bilirubinuria, and a special hemopoietic reaction of the bone-marrow, indicated by the presence in the blood of normoblasts, myelocytes, polychromatophilous erythrocytes, and erythrocytes with basophile granulations. The importance of recognizing this condition lies in the fact that permanent cure may be obtained by means of splenectomy.

The parasitic splenomegaly, that of **hookworm disease**, also requires mention. The profound anemia with sometimes greatly enlarged spleen, and the dropsy may mislead the observer into a diagnosis of splenic anemia, thus causing him to deprive the patient of thymol. The discovery of the parasite in the stools and eosinophilia always suggesting a parasitic disease, will, however, reveal the true identity of the case. **Ascari-ides** may also be attended with moderate enlargement of the spleen. Eosinophilia and examination of the stools of the suspected cases, children, as a rule, will reveal the cause. It is to be remembered also that hydatid or

echinococcus cysts may involve the spleen (see Tumors, at the end of this article), to the extent of about 3 per cent. of all cases. Cysts in this location may attain a large size and occur as primary growths in over one-half of the cases. In such the diagnosis cannot be made certain, unless an exploratory laparotomy be made, by puncture of the spleen, a dangerous procedure in that it may entail fatal toxemia, peritonitis, escape of hydatids in the peritoneal cavity or rupture, the latter occurring at times spontaneously.

Splenomegaly is often associated with hepatic disorders. In **cirrhosis of the liver** it is commonly present, but the hepatic symptoms usually predominate. It may be mistaken for the cirrhotic stage of splenic anemia, or Banti's disease, in which ascites, jaundice, anemia, and hemorrhage are also prominent symptoms. A history of alcoholism, the tardy initiation of hemorrhages, and of the splenomegaly will indicate the true condition present. In **Hanot's hypertrophic cirrhosis of the liver**, the frequently accompanying hemorrhages, jaundice, fever, and leucocytosis may suggest splenic anemia. But the large, hard and smooth liver, the persistence of jaundice instead of the mottled pigmentation, and the prominence of the hepatic symptoms point to the presence of Hanot's cirrhosis. The **hepatic cirrhosis with splenomegaly of childhood**, with anemia or jaundice, and gastric hemorrhages, is differentiated with difficulty from splenic anemia. In fact, it is probable that most cases described as such are advanced cases of the latter disease in which the Banti syndrome predominates. In **hemochromatosis**, charac-

terized by the presence in the skin and deeper organs of hematin, an iron-laden constituent of hemoglobin, the skin assumes a bronze hue, and enlargement of the spleen is commonly observed. This, however, occurs concomitantly with hypertrophy of the liver, the whole process leading ultimately to sclerosis of both organs, and also of the pancreas. In advanced cases glycosuria points to the disease present, but earlier, the slow progress, bronzing, hepatic enlargement, the absence of hemorrhages, and of the Addisonian asthenia point to the true nature of the disease.

Closely allied with the above disorders are some which might be grouped under the term **obstructive splenomegaly**, since any of them by causing portal obstruction can, whether the disturbance be cardiac, pulmonary, vascular, etc., induce passive congestion with distention of the spleen—sufficient at times, where the organ is the seat of degenerative lesions, to cause rupture. This readily explains the **indurative inflammatory splenomegaly** which occurs when the organ fails to undergo resolution after acute enlargement of the spleen attending acute infections, intoxications, etc. During this pre-sclerotic stage it may be the seat of focal hemorrhages and necrosis, while infarcts likewise are not uncommon. Abscesses may be formed, there being a marked tendency to accumulation of bacteria in the organ. Perisplenitis (treated separately below) is a common complication of the resulting splenic inflammation.

Finally, another group which will command increasing attention is one which might be classified under the head of **hemadenogenic splenomegaly**

—or enlargement of the spleen due to the blood-glands or internal secretory glands. Thus, rachitis, now known to be intimately connected with deficiency of the thymus and of the thyroid apparatus owing to their influence on calcium metabolism, is frequently attended with marked enlargement of the spleen. Dwarfing is not uncommonly associated with this condition and, precisely as we see stunted growth of hypothyroid and hypothyroid origin, so is there a **family form of splenomegaly** with dwarfing.

TREATMENT.—The multiplicity of causes of splenomegaly indicates the treatment to be adopted in each form, viz., elimination of the causal factor. In primary *tuberculosis* of the spleen, **splenectomy** has given 56 per cent. of recoveries, while death, according to Winternitz, invariably follows without it. **Tuberculin**, however, may prove useful early in the case. In *syphilis* **neosalvarsan**, **salvarsan**, **mercury**, or the **iodides** should be tried, but where the morbid phenomena assume those of splenic anemia **splenectomy** is also indicated. On the whole this operation is indicated where threatening symptoms, such as repeated gastric hemorrhages, intense hemolysis, etc., persist notwithstanding faithful effort to control the cause with drugs, unless leukemia or amyloid spleen be present.

In *chronic* inflammation, the **X-rays** tend to reduce the splenic enlargement. The treatment of the various causative diseases mentioned is given under their respective headings throughout the present work.

SPLENIC ANEMIA.

This disease is now generally regarded as embodying various dis-

orders which, though given individual names, are but stages of it. These are **primary splenomegaly**, which represents the initial stage of splenic anemia, and **Banti's disease** or **splenomegaly with hepatic cirrhosis**, deemed to be its terminal stage.

Splenic anemia is characterized by marked chronicity and progressive enlargement of the spleen, secondary anemia and, in some cases, terminal hepatic cirrhosis. It shows a predilection for males (about 60 per cent.) and for the third and fourth decade of life.

There exists a peculiar susceptibility of the spleen in children, not only to become enlarged but also to undergo histological changes. It is liable to enlarge with acute and chronic infectious diseases, with certain affections of the liver, and with twelve different diseases of the blood-producing apparatus. Its pathological conditions are more acute in children than in adults. Brinchmann (Norsk. Mag. f. Lægevidenskaben, Dec., 1915).

The morbid process in the spleen consists of hyperplasia followed by fibrosis affecting the pulp reticulum, its Malpighian bodies especially, and the capsule. The liver is at first the seat of passive congestion followed later by atrophic interlobular cirrhosis with calcification affecting mainly the portal veins, which vessels may become obstructed by thrombosis. That hemolysis is a factor of the morbid process is suggested by the formation of new hemolymph-nodes and deposits of blood-pigment, with compensatory proliferation of erythroblastic tissue.

A pathological study of 18 spleens from patients upon whom positive clinical diagnoses of splenic anemia had been made showed in each spleen

a hyperplasia of one or more of the constituent tissue elements. In 2 spleens the lymphoid tissue was so overgrown as to suggest lymphoma in one and lymphosarcoma in the other. In 3 spleens the proliferation of the endothelium of the venous sinuses was most predominant. In 13 spleens the process was chronic and diffuse. While any case of primary splenomegaly may begin as an overgrowth of the lymphoid tissue or of the endothelium, a secondary overgrowth of the stroma of the gland will later appear, accompanied by degeneration of the lymphoid or endothelial elements. As the connective tissue begins to undergo overgrowth, the spleen may be reduced in size, the roughness of the exterior being an index to the development of connective tissue within it. The histopathological picture presented in all 3 types of spleens from cases of primary splenic anemia harmonizes with the hypothesis of a slowly acting local toxin. L. B. Wilson (Surg. Gyn. and Obst., March, 1913).

In a case observed by the writers, the lymphatic glands in the abdomen had undergone a hyperplasia similar to that in the spleen. Blood was present in the lymph-sinuses of these lymphatic glands to a variable extent, but its amount bore no relation to the endothelial hypertrophy or fibrous tissue of the gland. These hemolymph-glands probably represent blood-organs *sui generis* in which the same pathological changes had occurred as in the other blood-organ, the spleen. Collins and Kiddell (Brit. Med. Jour., May 29, 1915).

Although some form of toxemia undoubtedly underlies the disease, its actual cause is still to be determined. It will probably be found due to various forms of intoxication. Various bacteria, syphilis, malaria, and other infections have been incriminated.

SYMPTOMS.—The only detectable symptom at first is an enlargement of the spleen. This increases

insidiously and very slowly without giving rise to other morbid phenomena, even the blood-picture remaining normal. After a few years anemia develops, though showing no characteristic picture. When the morbid process is advanced, the red corpuscles are reduced one-third or perhaps one-half, but the hemoglobin percentage shows greater decline—down at times to one-fourth. The leucocytes may also show considerable reduction in some cases, while in a minority there may be a leucocytosis. A relative lymphocytosis has been observed by some, but a differential count affords nothing characteristic. The anemia is chlorotic in type.

Another important feature is the tendency to gastric hemorrhages and hematemesis. It occurs in about one-half of the cases and is often profuse. While recurring at long intervals at first, the hemorrhages, which are due to passive congestion in the gastric mucosa, rupture of esophageal veins, and occasionally to erosions, become more frequent, particularly when the hepatic cirrhosis is advanced. Epistaxis, bleeding at the gums, retinal hemorrhages, ecchymoses, etc., may also appear at this time.

Pigmentation of the skin, suggestive of Addison's disease in its early stages, and most marked in the tissues exposed to light, is probably an expression of this proclivity to hemorrhage. Jaundice may precede it or accompany it, owing to hepatic cirrhosis. Ascites and edema of the ankles are occasional symptoms, as are also cardiac phenomena such as hemic murmurs, palpitations, etc., which are due to the existing anemia.

Among the general phenomena observed are digestive disorders due to

the gastrointestinal passive hyperemia, nausea, vomiting, diarrhea, etc., alternating with constipation, but they are apt to occur only in advanced cases. This applies also to the presence of albumin and granular casts in the urine, and to fever, seldom attaining more than 100° F., observed toward the decline of day. As the case becomes far advanced it may assume the hectic type, when marked asthenia is added. Death may be due to cardiac syncope following a severe hemorrhage or independently of such. As a rule, however, the patient is carried off by an intercurrent disease.

When the Banti stage of splenic anemia begins the symptoms are: (1) progressive increase or reduction in size of the spleen and change in its consistency; (2) the veins become more conspicuous, especially in the upper part of the abdomen; (3) symptoms of insufficiency on the part of the liver; defective bile production and also urobilinuria, uroerythrinuria, bilirubinuria, cholemia and clay-colored stools; defective transformation of urea, causing hypoazoturia; defective sugar metabolism, causing alimentary glycosuria and levulosuria; defective antitoxic action, increasing the urotoxic coefficient and defective elimination of methylene blue. There are the following accessory signs: (1) a tendency to hemorrhages; (2) pain in the liver region; (3) gastrointestinal disturbances, dyspepsia, etc.; (4) edema in the legs. Rummo (Policlinico, March 15, 1908).

DIAGNOSIS.—While percussion readily indicates the presence of an enlarged spleen, it is necessary to ascertain also the nature of the morbid process that is present. In **pernicious anemia**, the spleen is enlarged, but never to the same degree and the blood changes are characteristic; this applies to **leukemia** and to **Hodgkin's**

disease in addition to the enlarged lymphatic glands in the latter. **Con-genital hemolytic jaundice** differs from splenic anemia in that it appears early in life, shows urobilin and urobilinogen in the urine, and marked staining peculiarities of the red corpuscles. **Amyloid spleen** is distinguished by the history of syphilis, suppuration, or tuberculosis with amyloid disease in other organs. Late in the history of the case **hepatic cirrhosis** may be taken for it, but the greatly enlarged spleen and the history of the case permit differentiation.

TREATMENT.—Medical treatment sometimes proves of temporary benefit. **Arsenic** is especially useful if hemolysis is active, the case approximating, in some instances, one of pernicious anemia. **Salvarsan** or **neo-salvarsan** may also prove useful in such cases. **Iron** is indicated when the erythrocyte count is to any degree lowered. **Fresh air, sunshine, and liberal diet** are important. According to Rummo, **thorium X** causes a marked reduction of the spleen, an increase of red corpuscles, and in small doses polynuclear leucocytosis; large doses cause leucopenia. Mild applications of **X-rays** over the splenic region are given twice a week at the same time. **Benzol and olive oil**, equal proportions, beginning with a daily dose of 8 minims (0.5 Gm.) increased according to the patient's age and resistance to 30 minims (2 Gm.) and given while the X-rays and thorium are used, have procured good results. The blood should be examined daily.

Splenectomy is the only curative measure available, provided it is resorted to before the case is too far

advanced; it has proven effective, however, even after the Banti symptoms, hepatic cirrhosis, and ascites had developed. The operative mortality at the Mayo clinic has been 11.1 per cent. It is influenced, of course, by the condition of the patient. Before development of cirrhosis and ascites, the mortality was but 13.4 per cent. in 82 cases, while during that advanced stage it was 56.2 per cent. in 16 cases, according to Rodman and Willard (1913). Blake (1915) recommends the operation in either stage under the following conditions: 1. In adults, when the diagnosis is agreed on by a good physician and a competent surgeon. 2. When the condition of the patient is sufficiently good to withstand what may be a serious operation; or transfusions, when a poor condition can be sufficiently improved. 3. In children, only after a thorough trial of all possible medical methods of treatment, including fresh air, sunshine, careful nursing, liberal and appropriate diet, as well as the judicious use of drugs. In a large majority of cases, a high white blood-count, or a considerable recurring or continuous fever are contraindications.

Good results in 4 cases of advanced Banti's disease and 1 of malarial splenic enlargement with ascites by combining Talma's operation (**omentopexy**) with **splenectomy**. The changes in the blood-picture after operation were the same as those observed after splenectomy for other splenic affections, viz., the hemoglobin rose nearly to normal; the red-cell count exceeded slightly the normal, then gradually returned to the condition existing before intervention, and a slight leucocytosis, with pronounced eosinophilia, persisted. Febrile complications of ob-

scure causation may follow the operation. In thrombotic forms of splenomegaly, primary or secondary, medical treatment should alone be employed; 3 patients treated by splenectomy succumbed. Tansini and Morone (Rev. de Chirurgie, Aug., 1913).

Recent observations have tended to show that the anemia which follows splenectomy is best prevented by the use of **uncooked foods**.

The anemia which develops after splenectomy is most marked in animals on a mixed table-scrap diet of meat, bread, cereals, and vegetables, which is essentially a cooked diet. Further studies did not support the view that the anemia is due to lack of iron in the food. A diet of raw meat, as contrasted with cooked meat, shows a more severe anemia in animals on the cooked diet and suggests the possibility that heat alters some substances which, in the absence of the spleen, the body cannot utilize. Pearce, Austin, and Pepper (Jour. of Exper. Med., Dec., 1915).

GAUCHER'S SPLENOMEGALY.

This uncommon disease is characterized by the presence in the spleen and subsequently the liver, lymph-glands and bone-marrow of large, rounded or polygonal cells with small nuclei arising probably from the endothelium, and accumulations of iron-laden pigment. The spleen is greatly enlarged, owing to the development of these cells in dilated alveolar spaces and venous sinuses throughout the pulp. The liver may also be greatly enlarged and show the same cells in the lobules and interlobular connective tissue, the masses of iron pigment accumulating around the vessels and in the capsule. The abdominal and thoracic deep-seated lymph-nodes present the same characteristic and the bone-marrow likewise in cases of long duration.

Gaucher considered the condition a **primary epithelioma of the spleen**, but, as emphasized by Wilson at the Mayo clinic, it fails to show the attributes of malignancy, but rather of a form of hyperplasia resembling that observed in the thyroid, which leads to a secondary increase of the stroma, degeneration of the parenchyma, and finally fibrosis. This interpretation serves to eliminate the gloomy prognosis of malignancy and substitutes for it a comparatively favorable one, as experience has shown, where splenectomy can be resorted to.

The cause of Gaucher's splenomegaly is unknown, but its familial occurrence suggests a predisposition to some toxic or virus capable of irritating the follicles of the hematopoietic system.

SYMPTOMS.—The disease is usually recognized by a great enlargement of the spleen traceable to early life and its slow development, cases having been known to reach the fourth decade in which the process had started during childhood. The liver, which enlarges after the spleen, may also attain large proportions. Another peculiarity is its tendency to occur in several members of a family, but in the same generation and preferably in girls (85 per cent.). There is a marked tendency to epistaxis, bleeding at the gums, etc.

History of a family, 4 members of which suffer from the Gaucher spleen. Father and mother are both living and well; there is no tuberculosis in the family; nor could any luetic history be obtained, while a Wassermann reaction of mother proved negative. The mother has given birth to 4 children, and has had no miscarriages or stillbirths. Of the patients, Anna, the oldest child, is 11 years old.

Lily died in 1909 at the age of 8; Freda is 9 years old, and Max, the youngest, is 4 years old. Reuben (Amer. Jour. of Dis. of Child., Jan. 3, 1912).

There is a yellowish or brownish discoloration of the skin, especially where it is exposed to light; the face, neck, and hands, and particularly around the nose. According to Charles Herrman, there may also be wedge-shaped thickening of the conjunctiva on either side of the cornea. Secondary phenomena such as sensations of weight and pressure, gastric and intestinal distress, malnutrition, etc., may appear.

The blood-picture is not characteristic. There is a relatively slight anemia and a progressive decrease of the hemoglobin percentage as the case progresses. Leucopenia is always present with relative decrease of the polynuclears.

Case of primary splenomegaly of the Gaucher type in an infant 11 months old. The child had never thrived and weighed only 11 pounds. There was idiopathic enlargement of the spleen, liver, and lymph-glands, and a peculiar yellowish pigmentation of the skin of the exposed parts. The blood-picture was normal until a few days before death, when it assumed the appearance characteristic of lymphatic leukemia. Mason, Knox, and Wahl (Med. Record, Oct. 3, 1914).

TREATMENT.—All forms of treatment, including the prolonged use of X-rays, have failed. **Splenectomy** alone has afforded cures—evidence in favor of the non-malignancy of the disease. According to Erdmann and Moorhead (Amer. Jour. Med. Sci., Feb., 1914), the best cases for operative interference are those showing a practically normal blood-

picture with a hemoglobin percentage of 50 or more. Enlargements of the liver and glands are not contraindications if the general condition of the patient is good. The blood-picture soon returns to normal after the operation. The operative mortality is relatively low in appropriate cases.

SPLENOMEGALIC POLYCYTHEMIA, or ERYTHREMIA.

This disease, wrongly termed "Vaquez's" and "Osler's" disease, since these authors only aided to make it known by their writings, was first described by Rendu and Vidal in 1892. It is characterized by a peculiar mottled redness of the skin, with cyanosis, enlargement of the spleen, and striking increase of the blood-cells, both red and white.

SYMPTOMS.—The skin is brick red tinged with violet, the latter being due to cyanosis, especially noticeable at the lips, nails, buccal mucosa, and tongue. Hemorrhages from the nose, gums, stomach, intestines, skin, and genito-urinary tract are common. There is also enlargement of the spleen, sometimes considerable. The red cells may reach nearly three times the usual number, while the hemoglobin may attain 200 per cent. In most cases there is a marked leucocytosis, particularly of the polynuclear neutrophile variety. Greatly increased viscosity of the blood is another notable feature of the disease.

Among general symptoms are myasthenia and neurasthenia, headache, vertigo, and cerebral congestion, at times leading to apoplexy; neuralgia and spasmodic muscular disorders. Circulatory disorders with high blood-pressure are usual. Gastrointestinal and respiratory disorders are also wit-

nessed, particularly dyspnea due to pulmonary edema, though late in the history of the case. Edema of the extremities with dilatation of the heart, enlargement of the liver, and bronzing may then coincide with drowsiness or a semicomatose state which may end in death. Although a few cases reported have run their course in a few months, the patient may live six years or more.

ETIOLOGY AND PATHOLOGY.—Splénomegalic polycythemia occurs in both sexes about equally and seldom before the fourth decade. Formerly attributed to tuberculosis of the spleen, it is now thought to be due to violent stimulation by some undetermined toxic of the blood-forming organs, as shown by the presence of normoblasts, megaloblasts, and myelocytes in the blood, and the intense erythroblastic and leucoblastic congestion of the bone-marrow and spleen.

[It has been suggested by Saundby that the disorder might primarily be a neurosis associated with spasm of the arterioles and peripheral congestion. Such a condition might well produce the observed typical congestion of the blood-forming organs, but this form of vasomotor is so common an occurrence, while polycythemia is a relatively rare disease, that this interpretation of the process can hardly hold. S.]

The writer has collected reports on 179 cases of which 149 appeared to be instances of true polycythemia, the remainder being open to doubt. The condition must be differentiated from the relative increase in the red-cell count accompanying acute diarrhea, dysentery, etc., in which the volume of the blood is decreased, as well as from erythrocytosis, or secondary absolute polycythemia, typically seen in congenital heart disease, particularly pulmonary stenosis, in

chronic heart and lung diseases, and in certain individuals residing at great altitudes. It is marked, persistent, absolute, and of unknown origin. Lucas (*Archives of Int. Med.*, Dec., 1912).

TREATMENT.—This has not advanced beyond symptomatic measures, of which repeated venesections to reduce the volume of erythrocytes and other blood-cells have been found the most efficient.

[As it is the *proportion* of blood-cells to the volume of plasma which should be reduced, I would suggest **saline solution intravenously** after each bleeding as an additional measure which would tend also to reduce the abnormal viscosity of the blood, and therefore its excessive activating influence on hematopoietic organs, including the bone-marrow and spleen. S.]

The **X-rays** will serve to reduce the volume of the spleen but also the blood-count. Splenectomy is contraindicated, since the spleen is but a partial factor in the morbid process; it has, in fact, afforded bad results.

PERISPLENITIS; CAPSULITIS; CAPSULAR SPLENITIS.

This is an inflammation, acute or chronic, of the capsule and peritoneal covering of the spleen, which may occur as an extension of any disease affecting the spleen, itself or the organs immediately surrounding it. Part or all of the capsule may be involved. It may be simply inflamed, or it may produce a fibrinous or purulent exudate, become thickened. Adhesions may develop.

SYMPTOMS.—Discomfort or pain in the splenic area, radiating in various directions and aggravated by breathing; pressure, lying on the corresponding side and motion, and the splenic friction sound on auscultation, represent the array of symp-

toms added to those of the causative disease. It is readily confounded with inflammatory disorders of the pleura, but the absence of cough and dyspnea usually facilitates the diagnosis. Occasionally involvement of the diaphragm adds respiratory symptoms rendering recognition difficult.

TREATMENT.—Besides measures addressed to the causative condition, **strapping of the splenic area** is indicated, with **absolute rest** in bed. Derivative **purgatives** are also useful. If an accumulation of pus or an effusion can be detected, and absorption fail to occur under the use of **potassium iodide**, **laparotomy** should be resorted to, the incision being made at the outer edge of the left rectus and the spleen sutured to the abdominal muscles unless it be found already adherent. The morbid area is then opened and drained. If done with due care this procedure is fraught with no danger of complications.

TUMORS OF THE SPLEEN.

Primary tumors of the spleen are infrequent. Of the benign growths **fibroma**, which occurs rarely, is seldom discovered clinically. **Lymphangioma** and **angioma cavernosum** may, however, attain large size, especially the latter.

Cysts of various kinds are not uncommon. The **simple cysts** may be divided into **hemorrhagic cysts**, usually due to traumatism and traction upon the friable tissue of the organ, and infections; **lymph-cysts** due to accumulation of albuminous fluid, and **serous cysts**, when the content is non-albuminous and of low specific gravity. The two latter forms are degenerative products of the Malpighian bodies, broken-down splenic sub-

stance or vascular tumors. **Dermoid cyst** of the spleen is very rare.

Parasitic cysts are those most commonly met with. **Hydatid or echinococcus cyst** occurs in the spleen in about 3.5 per cent. of all cases. It is generally unilocular, and may develop in any part of the organ or in the adjoining tissues and attain large size.

Of the malignant tumors, **sarcoma**, though rare, is that most usually met with. It consists as a rule of nodules which project more or less from the enlarged organ. Occasionally the spleen becomes the seat of a metastatic sarcoma. **Carcinoma** of the spleen is exceedingly rare—likewise metastatic carcinoma.

SYMPTOMS.—In benign growths of sufficient size, particularly splenic cysts, the symptoms are those of a slowly growing tumor in the left hypochondrium. Pressure symptoms, or symptoms due to the mechanical weight of the mass, may develop, viz., indigestion, flatulence, at times nausea and vomiting as the result of pressure on the stomach, and constipation, from pressure on the bowel. A sense of soreness may also be noted over the mass, while pain, from mechanical traction, referred toward the left axilla and shoulder, is also frequently in evidence. There is always present a sense of discomfort. Objective symptoms are those of any large mass. The site of occurrence, the fact that the tumor dullness is confluent with the splenic dullness, the direct connection frequently found with the spleen by palpation, and the moving of the mass with respiration, all point to the spleen as the site of the origin of the tumor. The cystic character of a tumor is readily recognized by

the waves of fluctuation easily elicited. (J. H. Musser, Jr.) Lymphangiomas and angiomas sometimes give rise to palpable pulsations.

Hydatid or echinococcus cysts may sometimes be identified by the hydatid fremitus and by the simultaneous presence of a hydatid cyst of the liver. Diagnostic puncture of the cyst places the diagnosis on a sound basis, since the fluid obtained may contain hooklets, etc.; but the danger of peritoneal invasion by the latter, of secondary peritonitis, etc., render this procedure hazardous.

Sarcoma of the spleen develops rapidly. This feature, the nodules, radiating pain and tenderness, and the cachexia may facilitate recognition. Carcinoma is of slower development and is more likely to accompany a malignant growth elsewhere and to show involvement of other lymphatic structures. The lobulated character of the spleen and its hardness, if it is large enough to be palpated, the enlarged lymphatic glands and cachexia aid in establishing a diagnosis.

TREATMENT.—As a source of comfort pending operation, **adhesive plaster strips**, to prevent the harmful effects of motion of the enlarged spleen on other organs and to reduce the danger of torsion, may be employed when the growth is not large. When its dimensions are such, however, as to produce active symptoms an **abdominal bandage** to support the abdomen is preferable.

Where possible, **surgical removal** of the growth should be practised. In sarcoma it is contraindicated, but in benign growths **splenectomy** has proved uniformly curative, particularly in cysts. Other procedures such as **incision, drainage, and mar-**

supialization present greater dangers. A blood-cyst may be sutured to the incision in the abdomen and drained.

The incisions to reach the spleen number 28: (1) simple laparotomy incisions (23); (2) thoracolaparotomy; and (3) transdiaphragmatic laparotomy. The external rectus incision, due to the severe trauma caused and poor exposure, is not recommended. It is lower than the spleen and further exposure injures the costal arch. Incisions along the border of the ribs are better, also the modifications of the laparotomy incisions in which an oblique incision toward the left is made in addition. Still better approach is offered by resection or bending of the cartilaginous costal arch. Ssosan-Jaroschewitsch (Nautschn. Med., 4, 1920).

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SPLEEN, INJURIES OF. See ABDOMINAL INJURIES.

SQUILL (*Scilla*, U. S. P.; Squills) is the bulb of *Urginea maritima* or *Urginea scilla* (fam., Liliaceae), deprived of its dry, membranaceous outer scales, cut into thin slices, and carefully dried, the inner portions being rejected (being the youngest growth and deficient in activity). The active principles of squill are glucosides, three having been isolated by Merck, the last two of which are poisonous: *Scillin* (pale-yellow crystals, sparingly soluble in water, more freely soluble in alcohol and hot ether); *scillipicrin* (amorphous, yellow to yellowish-red, bitter, and hygroscopic powder, soluble in water); and *scillitorin* or scillain (brownish amorphous powder, soluble in alcohol, but insoluble in water and ether). Squill also contains a little volatile oil, sugar (about 22 per cent.), the peculiar mucilage *sinistrin*, and a large amount of calcium oxalate.

PREPARATIONS AND DOSES.—The official preparations are:—

Scilla, U. S. P. (the crude drug). Dose, 1 to 5 grains.

Acetum scilla, U. S. P. (vinegar of squill; used for the preparation of syrup of squill, and rarely used by itself). Dose,

15 minims (1 c.c.); best administered in an aromatic draught.

Fluidextractum scillæ, U. S. P. (fluidextract of squill). Dose, 2 to 3 minims (0.10 to 0.20 c.c.).

Syrupus scillæ, U. S. P. (syrup of squill; 45 per cent. acetum scillæ). Dose, $\frac{1}{2}$ to 1 dram (2 to 4 c.c.).

Syrupus scillæ compositus, U. S. P. (Coxe's Hive Syrup; 8 per cent. each fluidextracts squill and senega, and 0.2 per cent. tartar emetic). Dose, 20 to 30 minims (1.3 to 2 c.c.) in adults.

Tinctura scillæ, U. S. P. (10 per cent. squill). Dose, 10 to 30 minims (0.6 to 2 c.c.). This preparation fully represents the diuretic and expectorant qualities of squill. The official acetic acid preparations are not so uniformly dependable. (E. M. Houghton.)

Valuable unofficial preparations are:—

Mistura pectoralis, Stokes, N. F. (Stokes's Expectorant). Dose, 1 dram (4 c.c.) representing 1 grain (0.06 Gm.) ammonium carbonate, 2 grains (0.12 Gm.) each senega and squill, and 10 minims (0.6 c.c.) camphorated tincture of opium in syrup of Tolu.

Syrupus chondri compositus, N. F. III (Irish moss syrup). Dose, 2 drams (8 c.c.) representing $\frac{1}{8}$ grain (0.008 Gm.) ipecac, 2 grains (0.13 Gm.) each squill and senega, $3\frac{1}{2}$ minims (0.2 c.c.) camphorated tinct. opium, in mucilage of Irish moss.

PHYSIOLOGICAL ACTION.—Squill possesses emetic and stimulating expectorant and diuretic properties. Its physiological action as an expectorant has not been satisfactorily explained; its use is in large measure empirical. It apparently stimulates the bronchial mucous membrane, causing free and thinner secretion. As a diuretic, it appears to be effective by toning the kidney up through its irritant action; it does not, apparently, stimulate the secretory epithelia of the renal organs. Squill is eliminated by the bowels, kidneys, and bronchial mucous membrane.

Poisoning by Squill.—In toxic doses it produces violent irritation, and inflammation of the gastrointestinal and genito-urinary tracts, giving rise to nausea, vomiting, abdominal pain and purging, stranguary and hematuria. There is a marked fall in body temperature; the cir-

ulation becomes enfeebled; dullness, stupor and convulsions follow, and not infrequently death. Death has followed the injection of 24 grains (0.6 Gm.).

TREATMENT OF POISONING.—

The treatment of poisoning by squill is similar to that of digitalis poisoning. (See DIGITALIS, POISONING BY, vol. iv, page 136.)

THERAPEUTIC USES.—Squill is a useful expectorant in **subacute bronchitis**, when the sputum is tenacious, and raised with difficulty, or when the tonus of the bronchia is lowered and the sputa are very profuse (bronchorrhea). In **chronic bronchitis** squill is often advantageous, combined with other stimulating expectorants, as in Stokes's expectorant. Squill should never be given when fever and acute bronchial inflammation are present.

As a diuretic it is frequently given in **dropsical conditions**, whether the result of chronic renal disease or of the renal congestion following **chronic cardiac disease**, and in **chronic pleurisy** and **pericarditis** with effusion. If the kidneys are the seat of acute inflammation, squill is contraindicated. Niemeyer's pill is an efficient diuretic, containing 1 grain (0.06 Gm.) each of squill, digitalis and calomel.

Squill is frequently used as an emetic in **spasmodic croup**, seldom alone, but in the form of the compound syrup which contains tartar emetic; it is too depressing for general use as an emetic. In **whooping-cough** it is serviceable. W.

SQUINT. See STRABISMUS.

ST. ANTHONY'S DANCE.
See CHOREA.

ST. ANTHONY'S FIRE. See ERYSIPELAS.

ST. VITUS'S DANCE. See CHOREA.

STAPHYLORRAPHY. See SURGICAL ANAPLASTY, OR PLASTIC SURGERY: CLEFT PALATE.

STATUS LYMPHATICUS. See THYMUS GLAND AND LYMPHATIC SYSTEM, DISEASES OF.

STERILIZATION AND DISINFECTION.—The term sterilization refers to the process of rendering substances or articles absolutely free of live micro-organisms. Disinfection, though for practical purposes largely synonymous to sterilization, refers exclusively to the destruction of those organisms which are pathogenic.

Sterilization and disinfection may be divided into 3 forms: thermal, mechanical and chemical. These will be taken up in the order given.

THERMAL STERILIZATION.—This consists in the application of heat, and is the most effectual of all types of sterilization, though not always applicable. *Dry heat* includes actual combustion or burning, which can be carried out only in the case of worthless rags or infective discharges that are small in amount; the use of hot air, which is suitable for glassware and other articles that will stand a relatively high degree of heat, and the use of the thermocautery, appropriate for asepticizing infected tissues of the human body, such as the margins of openings surgically produced in the intestine for anastomotic purposes, the appendiceal stump, etc. Sterilization by hot air is usually carried out in a "hot air" or "dry wall" sterilizer, consisting of a metallic chamber provided with woven wire shelves and heated by burners beneath. Small objects may be readily sterilized in the kitchen oven. Heating to a temperature of 150° C. (302° F.) for one hour destroys all bacteria and their spores. Most fabrics, however, are injured by a temperature exceeding 110° C. (230° F.).

Moist heat, consisting in the application of steam to the articles to be sterilized, is far more satisfactory than dry heat, possessing greater penetrating power and acting more rapidly. Bacteria in the vegetative stage are immediately killed on exposure to steam, and most varieties of spores within a few minutes. Clothing, bedding, and the various muslin, cotton, or linen articles used in the practice of surgery, including gowns, caps, masks, towels, sheets, blankets, gauze sponges and pads, compresses, absorbent cotton, and dressing materials are best disinfected

by steam, though the latter injures silk and shrinks woolen fabrics, and ruins leather and fur, oilcloth, and objects made of impure rubber or wood, assembled with glue or coated with varnish. Steam may be employed either as *streaming steam* or *steam under pressure*. The former sterilizes in one-half to one hour and has the same disinfecting power as boiling water. It may often be applied without any special apparatus, any rough structure, not necessarily air-tight, serving as receptacle for the objects to be sterilized. The steam should be admitted at the top, in order the better to expel the heavier air at the bottom and secure penetration of the contained articles. In the laboratory small objects may conveniently be disinfected in the Arnold steam sterilizer.

Steam under pressure acts more powerfully than streaming steam, and is the favorite procedure in the routine sterilization of clothing, bedding, and surgical materials. Steam at a pressure of 15 pounds to the square inch sterilizes with certainty in twenty minutes, its actual temperature at such a pressure being 120° C. (248° F.). The smaller forms of apparatus for applying steam under pressure are known as autoclaves or digestors, and the larger forms as steam disinfecting chambers. The former consist of a strong metallic cylinder provided with a removable lid which can be fastened on tightly with screw bolts, a thermometer, safety valve, pressure gage, and stopcock for allowing escape of the air. Water is placed in the bottom of the receptacle and heat applied, generating steam. When the air has been thoroughly removed by steam escaping through the stopcock, the latter is closed and the pressure in the apparatus rises, the overheated steam actively sterilizing the contained articles. Where fluids are sterilized in the autoclave, the latter must be allowed to cool before being opened, lest the fluids boil over or their receptacles burst.

The larger steam disinfecting chambers are usually rectangular or cylindrical in shape, and may be employed either with steam under pressure or streaming steam, with formaldehyde gas or formaldehyde and dry heat, or with combinations of

these agencies, either without or with a vacuum. The chamber comprises an inner and an outer shell, forming a steam jacket into which steam is passed before the objects in the central chamber are exposed to the steam, thus heating these objects and preventing condensation of the steam on them (and the consequent wetting) when disinfection is begun. An attachment known as the ejector is provided which when in use rapidly creates a partial vacuum in the central chamber and favors penetration of the steam into the interstices of fabrics and remote corners, to replace the air withdrawn by it. The best forms of steam disinfecting cylinders open at both ends, in order that the infected material, introduced at one end, may be removed at the other with less risk of reinfection. In well-equipped disinfecting establishments a dividing wall passes across the disinfecting cylinders to separate completely the receiving end and attendants who prepare the material for treatment from the discharging end, where the disinfected material is aired, dried and repacked by other attendants. Light cars with trays are provided to facilitate introduction into and removal from the apparatus. Densely packed bundles of rags, cotton, hair, etc., must be loosened before their introduction to insure disinfection throughout.

Intermittent, discontinuous, or fractional sterilization consists in exposure of the materials to be sterilized to steam (without extra pressure) for 15 minutes on each of three successive days. Prolonged application of heat, or the use of heat at a temperature exceeding 100° C., is thus avoided.

Boiling water, left in contact for one hour, will kill all pathogenic micro-organisms, excepting possibly the spores of tetanus and anthrax. In fact, the germs of typhoid fever, cholera, dysentery, pneumonia, tuberculosis, plague, diphtheria, erysipelas, and practically all the non-spore-forming organisms, are destroyed at once by boiling and likewise by exposure to 60° C. (140° F.) for 20 minutes (Rosenau). Boiling water is eminently suitable for the disinfection of table and kitchen ware, urinals, and cuspidors, and most kinds of fabrics. Cleansing with

boiling water, especially if mercury bichloride or phenol be dissolved in it, efficiently disinfects walls and floors, metal objects, beds, etc. When oily or organic matters are disinfected with it, admixture with a strongly alkaline soap, lye, or borax is of advantage to augment its penetrating power. In the operative room boiling is employed especially for the sterilization of metal instruments, a special tank such as the Schimmelbusch sterilizer, heated by gas-burners beneath, being generally employed. Sterilization is effected by boiling for 10 minutes in a 1 per cent. solution of sodium carbonate, the latter serving to prevent rusting and injury to cutting edges. Removal from the sterilizer may be accomplished with a perforated tray and long hooks, or, in the case of single instruments, with forceps. Knives are boiled for 2 minutes only in racks designed to maintain their edges uppermost; needles for 3 minutes in an open metal box, and scissors and cutting forceps for 5 minutes. The lid of the sterilizer should be in place during the process. Boiling is also employed frequently in the sterilization of rubber articles and in that of Pagenstecher thread, linen thread, silk, silkworm gut, horsehair, and silver wire. Rubber drainage-tubes may be boiled for one-half to one hour in 1 per cent sodium carbonate solution, rubber dam likewise in saline solution, rubber tissue and gloves for five minutes only and finger-cots for one minute. Sterilization of water itself is readily effected by boiling, either with the aid of as simple an apparatus as an alcohol lamp and spoon or can, or with special apparatus ranging from the more inexpensive types to the large water sterilizers used in hospitals or for other purposes.

Sterilization of solutions of drugs or other substances unfavorably modified by boiling may be effected by repeated (intermittent) exposure to a temperature of 65° C. (149° F.). *Pasteurization*, which, as applied to milk, consists in heating once to 60° C. (140° F.) for 20 minutes, or better—to provide a factor of safety—to 65° C. (149° F.) for 30 or 45 minutes, is a fairly trustworthy procedure for rendering milk or other fluids free of pathogenic

germs, but a process of disinfection and not of sterilization, since a small proportion of the non-pathogenic organisms, including the lactic acid bacteria, remain undestroyed by the degree of heat applied.

Sunlight, the *ultra-violet rays*, and *electricity* may, for convenience, also be considered under the heading of thermal disinfection. The first named possesses distinct germicidal properties, though its variability and uncertainty are disadvantages. The blue-violet and ultra-violet rays are alone active, the yellow and red rays having practically no germicidal power. Even diffused light has an antiseptic action. Tubercle bacilli are less easily killed by sunlight than the cholera and plague organisms. The ultra-violet rays, as supplied by the Cooper-Hewitt mercury-vapor lamp, are strongly germicidal, and are being availed of for the sterilization of water, milk, etc., even upon a large scale, as in purifying a municipal water-supply. Thresh and Bealle showed that these rays would, in clear water, kill many bacteria in 5 to 20 seconds and even resistant spores in 30 to 60 seconds. Electrical currents, except in so far as heat is liberated, have but little germicidal power, and the Röntgen rays none.

MECHANICAL STERILIZATION.—

The mechanical cleansing constitutes a method of sterilization which, though inefficient in itself, acts as an important preparatory influence or mordant for the subsequent application of chemical disinfectants. Under this heading belongs, *e.g.*, the preliminary scrubbing of the hands with green soap and water in the preparation of the surgeon for operative procedures. The process is so bound up with chemical disinfection as to be more profitably taken up when the occasion presents under the next heading.

CHEMICAL STERILIZATION.—The mode of action of the various disinfectants, including, in particular, mercury bichloride (see Mercury and Wounds), carbolic acid (see Phenol), creolin (see Cresols), hydrogen peroxide (see Hydrogen dioxide), potassium permanganate (see Manganese), alcohol (see Alcohol), formaldehyde (see Formaldehyde), boric acid (see Boric acid), iodine (see Iodine),

and iodoform (see Iodoform), has already been taken up. Reference to chemical disinfection will here be limited, therefore, to a comparison of these various agents and an account of their mode of practical application for various purposes.

The careful tests reported in 1910 by Post and Nicoll showed that the *Bacillus typhosus* could be destroyed in one minute by the following agents: Argyrol, 10 per cent.; protargol, 10 per cent.; silver nitrate, 1 per cent.; mercury bichloride, 1:500; mercury biniodide, 1:1000; phenol, 5 per cent.; trikresol, 1 per cent.; iodine tincture, undiluted, 7 per cent.; official formaldehyde solution, undiluted; alcohol, 50 or 70 per cent.; tincture of green soap and hydrogen dioxide, undiluted. The following preparations proved ineffectual: Silver nitrate, 1:1000; phenol, 1 per cent.; trikresol, 0.3 per cent.; lysol, 1.5 per cent.; creolin, 1 per cent.; formaldehyde solution, 1 per cent.; alcohol, 20 or 30 per cent.; potassium permanganate, 1:1000; copper sulphate, 1 per cent.; boric acid, saturated (1:18) solution; potassium chlorate, saturated (6.6 per cent.) solution; glycerin, undiluted, and distilled water. With the streptococcus, gonococcus, and pneumonia the results were, with few exceptions, similar, though failures to disinfect were somewhat more frequent in the case of these organisms than with the typhoid bacillus, *i.e.*, stronger solutions were generally required. Among the salient items of knowledge gained from studies of this kind have been the importance of organic matter, *e.g.*, blood-serum, in interfering with the action of germicides, and the marked inefficiency of such preparations as liquor antisepticus, U. S. P., listerine, alkalol, and glycothymoline in destroying bacterial life.

Practical Uses of Chemical Disinfectants.

—*Disinfection of the Surgeon's Hands.*—The procedure generally followed consists in first scrubbing the hands vigorously for 5 minutes with soap and a brush in hot running water. The nails are then cleared of foreign material and the scrubbing repeated for 5 minutes more. The latter should be rinsed off frequently. The hands are then rinsed in 1:3000 mercury bichloride solution or Harrington's solution followed by sterile water and the

sterile gloves either put on wet in the antiseptic solution or after drying the hands with a sterile towel. Where it is desired to operate without gloves, the hands may be dipped in a **bichloride-permanganate solution** (potassium permanganate, 1 ounce; bichloride, $7\frac{1}{2}$ grains; hot sterile water, 1 quart), rinsed in cold 1:3000 or 1:4000 bichloride solution in 50 per cent. alcohol every 5 minutes during the operation, and after the operation treated with a hot saturated solution of **oxalic acid** to remove the remaining permanganate, followed by warm water and a cold **ammonia solution** (ammonia, 1 ounce, water 2 quarts). To disinfect the hands after septic operations a small quantity of **chlorinated lime** and of **sodium carbonate** may be rubbed into the skin with water for a few minutes, then rinsed off with warm water.

For the general practitioner Kolle (1907) and Tavel have endorsed **Schumberg's procedure** of scrubbing the hands thoroughly with a mixture of 2 parts of alcohol to 1 of ether, to which 0.5 per cent. of **nitric acid** has been added. This mixture, besides disinfecting directly, shrivels up the skin and confines the germs in its crevices for several hours; it produces no irritation of the skin, even upon repeated use. Heusner, for skin disinfection, has recommended the use of a solution of 1 part of **iodine** in a mixture of 750 parts of **benzine** and 250 parts of **liquid petrolatum**. E. McDonald (1915) asserts that a solution of **commercial acetone**, 40 parts; **denatured alcohol**, 60 parts, and **pyxol**, 2 parts, will completely sterilize the hands in 30 seconds. McMullen has used **McDonald's solution**, after scrubbing with **green soap**, water, and alcohol with success.

Disinfection of the Operative Field.—On the afternoon of the day preceding that on which the operation is to be performed the skin of the operative field should be shaved, then washed thoroughly with soap and warm water, rinsed with cold water, then rubbed with **alcohol** and **mercury bichloride** 1:5000, and thoroughly dried. Over areas of thick skin such as the elbow, knee, and sole of the foot **borosalicylic compresses** (salicylic acid, 15 grains, and boric acid, 90 grains to the

pint) should be applied and renewed every four hours, the loosened epithelium being removed by sponging with alcohol. If the preparation has been thorough, painting the operative field and surrounding area with **tincture of iodine** is alone necessary at the time of the operation. If not, the parts should be scrubbed for 3 minutes with soap, hot water, and sterile gauze, the skin sponged carefully with **Harrington's solution** (water, 30; alcohol, 60; **hydrochloric acid**, 6; **mercury bichloride**, enough to make a 1:1250 solution) and dried with **ether**, and the area finally painted with **tincture of iodine**, beginning at the line of incision (Fowler). Whiting (1914) recommends an iodine tincture made with 70 per cent. alcohol.

Sterilization of Surgical Paraphernalia.—**Rubber goods**, after sterilization by heat, may be kept sterile in 50 per cent. alcohol or a 1:40 or 1:20 solution of **phenol**. **Glass instruments** such as drainage-tubes, syringes, nozzles, droppers, and medicine glasses may be kept, after **boiling**, in a 1:1000 **bichloride solution**. **Filiform bougies** should be washed, without boiling, with **soap** and **water** and placed in 1:40 **phenol** shortly before use, then rinsed with sterile water. **Tourniquets** and **rubber bandages** may be washed with **soap** and **water** and rinsed in 1:100 **phenol**. **Hand-brushes** may be sterilized by **boiling** for ten minutes in 10 per cent. **potassium bichromate solution**, then kept in jars containing a 10 per cent. **bichromate solution** in 1:1000 **mercury bichloride**. **Catgut** is sterilized by **boiling** for 1 hour in **alcohol** on each of 3 successive days, or by boiling in **cumol**. It may also be sterilized (**Bartlett method**) by heating gradually in asbestos to 220° F. in the course of 2 hours, placing it in an asbestos-lined kettle containing liquid **albolene**, allowing it to remain there until cleared (usually in a few hours), and finally heating gradually on a sand-bath to 320° F., which temperature is maintained for one hour. **Silkworm gut** and **horsehair**, after sterilization by **boiling**, may be preserved, respectively, in a 1:30 **phenol solution** and 1:1000 solution of **mercury bichloride** in **alcohol**.

Disinfection of Bed and Body Clothing.—Such articles, after contact with cases of

communicable disease, if not disinfected by heat, may be immersed in phenol, 5 per cent.; formaldehyde, 10 per cent., or mercury bichloride, 1:1000. If soiled with discharges, they should previously have been heated under antiseptic precautions with 3 per cent. soft soap, to 50° C. for three hours and two days later boiled for half an hour in water containing 1:3000 of petroleum and 1:120 of soft soap (Rosenau).

Disinfection of Bath Water.—Water used in bathing a patient and contaminated by his secretions may be disinfected by mixing with the bath water $\frac{1}{2}$ pound of chlorinated lime and allowing it to stand half an hour (McClintic).

Disinfection of Feces, Urine, and Sputum.—The following methods may be used: (1) Add a 5 per cent. solution of crude carbolic acid to an equal bulk of excreta, mix thoroughly, and allow to stand one or two hours; (2) similar employment of a 10 per cent. formaldehyde solution; (3) add an equal quantity of freshly prepared milk of lime containing 1 part of freshly slaked lime to 4 parts of water, and allow to stand at least 2 hours (the reaction of the mixture of lime and excreta must be alkaline if success is to be attained); (4) add an equal amount of a 3 per cent. solution of chlorinated lime, mix thoroughly, and allow to stand for 2 hours.

In the disinfection of feces and urine, in the absence of chemicals, a bucket of boiling water added to a stool, which is then covered and allowed to stand until cool, will destroy practically all bacteria except the spore bearers (Hasseltine). Arnould (1914) has recommended the use of copper sulphate, 6 or 7 grains to one liter of stools, combined with the addition of sulphuric acid, 5 per cent., for the destruction of typhoid and cholera organisms. In the disinfection of privies, cess-pools, etc., lime and chlorinated lime are commonly used.

Disinfection of the Sickroom.—This is usually best effected with formaldehyde gas, though in the case of yellow fever, malaria, and plague insecticide agents must be especially employed. Articles such as bedding, carpets or rugs, and upholstered furniture, if left in the room during the infective period, should prefer-

ably be left in place until a preliminary gas disinfection has been performed, then removed for sterilization by steam. Objects to be removed from the room for disinfection should be wrapped in a sheet or bag wet with mercury bichloride solution. Before disinfection of the room, the latter should be rendered gas-tight, all cracks and crevices being sealed by pasting paper over them, and hearths or flues likewise closed off. The articles remaining in the room should be arranged so that the disinfecting gas will gain access to all surfaces possible. Of the various methods of generating formaldehyde gas for disinfection, Rosenau considers most reliable the permanganate-formalin method. This involves the use of 10 ounces (300 c.c.) of commercial formaldehyde solution and 5 ounces (150 grams) of potassium permanganate for every 1000 cubic feet of air space. The formalin is poured over the permanganate, previously placed in a deep bucket or basin, separated from the flooring (owing to the heat evolved) by a board. Formic acid and heat are set free in the ensuing chemical reaction, the heat, in turn, liberating formaldehyde gas. Proper formaldehyde disinfection requires a temperature of 65° F., or higher, and a humidity of 65 per cent. at the beginning of the process (Hasseltine). A control test should preferably be established to determine the efficiency of the disinfection; this is done by exposure in the room of a strip of (sterile) filter-paper touched with a drop of a broth culture of *B. prodigiosus* or other harmless organism, and inoculating broth with the filter-paper at the close of the process. Spraying formaldehyde solution is a simple and useful procedure for disinfecting closets, cabinets, wardrobes, and bureau drawers, but is not satisfactory in larger rooms. The formalin must be sprayed directly upon the articles to disinfect. In disinfecting small rooms a sheet may advantageously be hung across the room and sprinkled freely with formalin. The room should be kept closed not less than 8 hours. The formaldehyde disinfection should preferably be followed by thorough mechanical cleansing, sunning, and airing.

Purification of a room without a gaseous

disinfectant may be carried out by removing all the movable articles in the room one by one for disinfection outside and mopping the surfaces in the room with 1:1000 mercury bichloride solution or one of the alkaline cresols. It is believed by many that the results after thorough mechanical cleansing compare favorably with those obtained by gaseous disinfection. The walls should be carefully brushed with the suction brush of a vacuum cleaner and the floors and woodwork thoroughly scrubbed with hot water and soap or a disinfectant solution.

For rooms in which fumigation against diseases transmitted by insects or rats is indicated, sulphur dioxide should preferably be used. The room to be fumigated should be tightly sealed and all fabrics and metallic objects which are apt to be injured by the gas removed. The gas is usually set free by burning sulphur, of which at least 2 pounds for every 1000 cubic feet of space should be used, or 5 pounds where a germicidal action (surface disinfection only) is desired. The sulphur is best burned in large, flat, iron pots, each placed in a tub of water, and the latter, in turn on a table or box. It is best ignited by making a little hollow in the middle of the sulphur, pouring in some alcohol, and igniting the latter. In destroying vermin an exposure of 2 to 12 hours is sufficient; for a germicidal effect, 6 to 24 hours. The gas may also be liberated from liquid sulphur dioxide, which is marketed in cans, and is merely poured into a washbowl or iron pot. Two pounds of the liquid are equivalent to one pound of sulphur. The germicidal action of sulphur dioxide is favored by moisture.

Sulphur dioxide is applicable to the disinfection of stables, outhouses, freight-cars, the holds of ships, etc. **Hydrocyanic acid gas** is available for similar purposes (see Hydrocyanic Acid).

Disinfection of Passenger Cars.—Where contamination with the virus of a transmissible disease is known to have occurred, the car should be disinfected precisely like a room. Prophylactic disinfection consists in treatment with formaldehyde gas, followed by removal of carpets and seats for vacuum treatment and several hours' exposure to sunshine,

and by mopping or scrubbing of the floor with a disinfectant solution.

Disinfection of Books.—Books handled by persons suffering from contagious diseases may be disinfected by placing 2 or 3 drops of commercial formaldehyde solution on every second page (taking care to distribute the drops well), laying the books in a closed box in which more solution has been sprinkled, and leaving the box in a warm place for at least 24 hours. Larger numbers of books may be disinfected while standing widely open on wire trays in special chambers. After institution of a partial vacuum, a high percentage of formaldehyde, together with a temperature of 80° C., is applied for 12 hours (Rosenau). Books merely exposed in a sickroom, without having been handled, require no disinfection save surface exposure to formaldehyde gas. S.

STILLINGIA.—*Stillingia* (Queen's root or delight, yaw-root, silver-leaf) is the dried root of *Stillingia sylvatica* (fam., Euphorbiaceæ). The activity of *stillingia* is due to a volatile oil (3 to 4 per cent.), a fixed oil, a resin known as *sylvaerol*; tannin is present to the extent of 10 or 12 per cent., and a small amount of gum and starch. The volatile oil has a strong and unpleasant odor. The fixed oil is soluble in ether, and is as acrid as the resin *sylvaerol*, which can be extracted by alcohol or chloroform.

PREPARATIONS AND DOSES.—The official preparations are:—

Stillingia, U. S. P. (the crude drug). Dose, ½-1 dram (2 to 4 Gm.) in decoction.

Fluidextractum stillingie (fluidextract of *stillingia*). Dose, ½-1 dram (2 to 4 c.c.).

Syrupus stillingie compositus, N. F. (compound syrup of *stillingia*). Dose, 1 dram (4 cc.). Contains *stillingia*, *corydalis*, *iris*, *sambucus*, *chimaphila*, *coriander*, and *xanthoxylum*.

PHYSIOLOGICAL ACTION.—In small doses, frequently repeated, it is believed to stimulate the various secretions, acting as an alterative. It is also regarded as a stimulant to the heart and circulation.

In large doses, *stillingia* is a strong irritant to the gastrointestinal tract, producing nausea and vomiting, and violent catharsis.

THERAPEUTIC USES.—*Stillingia* was formerly employed as an active alterative, but evidences of its virtues are lacking. It has been used, especially in the Southern States, as an alterative in **syphilis**, **scrofula**, **chronic liver disorders**, and **chronic skin affections**. In **jaundice**, **hemorrhoids**, **constipation**, and **disordered digestion from insufficient action of the liver**, *stillingia* has been much used. The compound syrup (N. F.) is used as vehicle for potassium iodide in **syphilis**, **chronic rheumatism**, etc. W.

STOKES-ADAMS DISEASE.

See HEART AND PERICARDIUM: HEART-BLOCK.

STOMACH, CANCER OF.—

Reliable recent statistics show that carcinoma of the stomach is on the increase. In 1913 over 75,000 deaths were attributable to this cause in the United States alone, while, according to Smithies, over one-half million deaths occurred throughout the civilized world in the same period.

ETIOLOGY.—The disease occurs with the greatest frequency between the ages of 40 and 70. The theories advanced in explanation of the atypical epithelial proliferation, based on embryonic rests, infection, chemical, thermic, traumatic, and infectious irritants, do not explain all the phenomena of gastric cancer. An attempt has been made to implicate occupation, alcohol, tobacco, traumatism, diet, heredity, but none of these factors has yielded a satisfactory clue. Sex incidence shows approximately three males afflicted to every female.

The frequency with which carcinoma is engrafted upon ulcer justifies active study in this direction. Approximately 60 per cent. of all cases of gastric carcinoma operated upon at the Mayo Clinic, according

to Wilson (collected papers of St. Mary's Hosp., Mayo Clinic, pp. 149, 1913) gave a long history of gastric distress, *i.e.*, averaging 11.4 years prior to a short history (average six months) of severe symptoms due to gastric cancer. The remaining 40 per cent. gave short histories, averaging seven months. Of the specimens examined 60 per cent. showed ulcers with bases free of cancer, while about 40 per cent. showed them to be uniformly cancerous.

These statistics are somewhat higher than those reported in other parts of the country, and higher than my own. MacCarty believes that the cancer cell in the stomach comes from the intraglandular hyperplastic cells of the mucosa and represents a terminal malignancy in the pre-existing hyperplasia.

SYMPTOMATOLOGY AND DIAGNOSIS.—Gastric carcinoma is attended by symptoms due, on the one hand, to the effect of the disease *per se*, namely, weakness, emaciation, cachexia, loss of weight, and, on the other, to the specific action on the gastric walls, namely, epigastric tumor, loss of appetite, nausea, vomiting, and interference with gastric function. Pronounced disturbances in motility and secretion can occur, varying with the location of the tumor.

An important question is the problem of early diagnosis. Every method available must be brought to bear. Several fundamental points must be borne in mind. Carcinoma must be recognized before emaciation, anemia, weakness, tumor, and cachexia appear; in the presence of these symptoms the case is already inoperable. Secondly, the very first stage of can-

cer, represented merely by an isolated group of aberrant cells, can hardly be diagnosed, because radiologically it will not deform the image and physiologically it will not interfere with function. Therefore, when we witness an actual disturbance, the disease is already advanced.

The patient does not consult the physician until definite symptoms are present, and yet definite symptoms often spell disaster. How, then, are we to cope with the condition? By educating the public to the frequency, danger, and necessity of early diagnosis, and then by submitting any persistent gastric condition which appears during the "cancer" age to all diagnostic methods available.

The means at our disposal are: (1) history and clinical examination; (2) laboratory diagnosis, bacteriological, serological and chemical; (3) X-rays. Graham (collected papers, St. Mary's Hosp., Mayo Clinic, 1913) recognizes three types of history in gastric carcinoma: First, a long precancerous history, often years in duration, clearly an ulcer history (40-42 per cent.); second, those who for months or years past had gastric symptoms, but who for months or years have had freedom from discomfort; third, those whose trouble came as a thief in the night or who have seemed to leap from health to grave disease,—the latter, 58 per cent. less than two years. As histories are better studied group 3 decreases and groups 1 and 2 increase proportionately.

The symptoms vary with the topography and nature of the growth. Again, the course varies according to whether the patient has been previously in perfect health or whether the growth is engrafted on the ulcer.

Pain is almost constant, usually dull, boring and continuous. As a rule, it is not intense, but shows exacerbations after the taking of food. Occasionally, food relieves it. It is often described as "burning," "soreness," "aching," with a feeling of fullness and discomfort. A few cases, up to an advanced stage, show no definite pain.

Vomiting appears as the disease progresses. In pyloric cancer it may occur early and yield a rancid, foul material. In the ulcer carcinomatous type all the signs of gastric dilatation with hypersecretion may be present.

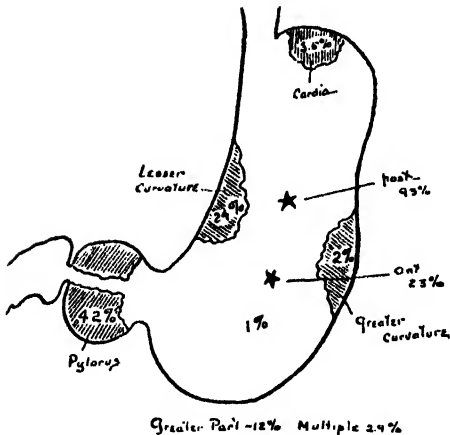
Gas is ejected in many cases along with bitter or sour eructations, although often the symptom is simply a troublesome aërophagia.

Anorexia occurs rather early, and may later be associated with nausea. Soon all desire for food is lost, particularly for meats. Yet in medio-gastric carcinomata and in non-obstructive neoplasms, the appetite, considering the gravity of the lesion, is often good.

In a number of cases emaciation, loss of weight and anemia occur before any localizing symptoms become apparent; in another group gastric symptoms will dominate the picture; while in the course of a chronic-ulcer history the heartburn and burning may abate and the pain become almost constant, with, probably a gradual change in the gastric chemistry, with sudden or gradual loss of weight. While constipation is more frequent, diarrhea may occur, with foul, putrid stools and signs of secondary intestinal infection. Again, vomiting may be the first symptom witnessed.

Often the symptoms are so mild that the patient hesitates to consult a physician until the disease is practically inoperable.

On the whole, the wise physician should realize, in the presence of any of these symptoms during the "cancer" age, the necessity for a *careful and exact study of gastric function* and *will not wait for the development of the characteristic picture* which, when found, indicates that the process is already too far advanced.



Frequency of carcinoma in different parts of the stomach. (After Smithies' table; 851 cases.)

Tumor.—In about 50 to 60 per cent. of cases a tumor is found (95 per cent. of gastric tumors are carcinomatous—Graham: collected papers, St. Mary's Hosp., Mayo Clinic, p. 180, 1913). In some cases hepatic disease or widespread lymph-node involvement can be determined. Pyloric cancer with gastric dilatation can easily be demonstrated, but the findings of early gastric carcinomata are practically limited to those of the laboratory and the X-ray.

Laboratory Diagnosis.—While no definite pathognomonic methods have

as yet been elicited, there are certain phenomena of great diagnostic importance. Examination of the stomach is made particularly by means of the test-meal and its many modifications. One should investigate the following: (1) the empty stomach; (2) gastric motility; (3) gastric secretion; (4) presence of substances indicative of neoplasm.

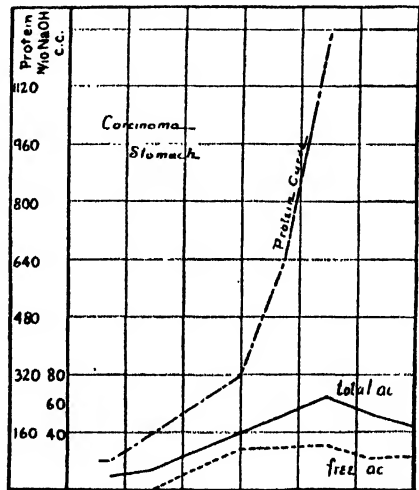
In gastric carcinoma more than one-half the cases (69 per cent. Smithies-Ochsner: "Cancer of the Stomach," 1916) show food retention. Obviously, these cases were examined in an advanced stage. In the empty stomach, instead of the normal bacterial flora and leucocytic content, with a moderate amount of mucus and squamous epithelia and an appreciable total and free acidity, the quantity in carcinoma exceeds normal (50 c.c.), and is usually made up of a purée of leucocytes (pus), blood, macroscopic or occult, and often disintegrated and necrotic tumor particles. Bacteria are numerous and mixed, and associated, possibly, with the Oppler-Boas bacillus. Smithies found lactic acid in 66.8 per cent., and no free hydrochloric acid in 66 per cent. This represents the average frequency, although in a series I have studied, confirmed by operation, I have been surprised at the relatively high total and free acid figures seen in some cases. Smears should be made, stained, and studied for neoplastic tissue and irregular mitotic cell formations. Often an excess of mucus is found.

The regular **Ewald meal** is given (35 grams of toast and 250 c.c. of tea or water), or any of the mixed meals. Even the water meal may be used, showing admirably the food rests,

neoplastic *débris*, and epithelial desquamation. The meal can be extracted by the old method, or, better, by the fractional tube at intervals and the exact trend of digestion followed. *Evidence of early carcinoma is often found only in certain samples. It causes a downward trend in secretion, both as to quantity and acidity.* In our studies this seems to hold true, whether the cancer be primary or implanted upon an old ulcer with hypersecretion. Normally an Ewald meal is evacuated within two and one-half hours. If this meal remains for some time longer, as can easily be demonstrated by the fractional technique (see below), disturbed gastric motility exists. In mediogastric carcinoma and carcinoma high up in the stomach we have usually found no interference with motility. In antrum and pyloric carcinomata motility disturbances are common. The digestive curve, instead of reaching its height in one to one and one-half hours, usually shows a subacidity. *It is a mistake to wait for achylia or anacidity in the diagnosis of gastric carcinoma.* Many cases never show complete achylia. High acidity is not infrequent in carcinomatous ulcer.

When the stomach walls are relatively approximated, blood, pus, mucus, and tumor *débris* can be found, while frequently absent at other times. The time, therefore, to search for intragastric evidence of carcinoma is on the empty stomach and at the extreme end of digestion. The classical syndrome of no free acid, lactic acid, and Oppler-Boas bacilli is usually a death warrant. *If we are to benefit these cases by early diagnosis, the diagnosis must be made before these findings appear.*

Smithies showed that lactic acid is present in the meal in 34.3 per cent. of retention cases, and only 16 per cent. of non-retention cases; the average total acidity was 32 and the average free acid was 9.2, while the meal showed bacilli of the Oppler-Boas variety in 87.2 per cent. in the retention group and in 36 per cent. of the non-retention group. These findings closely approximate our own. In operatively confirmed car-



Protein, total acidity and free acid curves in case of gastric carcinoma. (Clarke and Rehfuß.)

cinoma, absence of many of the supposed typical findings is apparent.

We have pointed out (Clarke and Rehfuß: Jour. Amer. Med. Assoc., lxiv, p. 1737, 1915) that in cancer the protein curve of gastric digestion is out of all proportion to the acid curve, and have described the fractional technique by which this study can be made. In doubtful cases, its application is of great value, and indicates that there is some substance poured out from the neoplasm, increasing in concentration as digestion goes on.

Many methods have been devised to show neoplasm by gastric analysis:—

- (1) Deviation in acid and ferments.
- (2) Presence of organic acids.
- (3) Increase in nitrogen or protein:
 - Nitrogen content. (Salomon: Deut. med. Woch., xcvii, p. 499, 1909.)
 - Albumin content. (Wolff and Junghans: Berl. klin. Woch., nu. 22, 1912.)
 - Fractional protein content. (Clarke and Rehfuß: Jour. Amer. Med. Assoc., lxiv, 1737, 1915.)
- (4) Glycyltryptophan. (Neubauer and Fischer: Deut. Archiv f. klin. Med., xcvi, p. 499, 1909.)
- (5) Tryptophan. (Weinstein, Sanford and Rosenbloom: Jour. Amer. Med. Assoc., lv, p. 1085, 1910.)
- (6) Amino-acids. (Barlocco: Berl. klin. Woch., xlvii, p. 1536, 1910.)

Salomon showed that the wash water after a special technique in non-carcinomatous cases contained from 0 to 16 mg. of nitrogen per 100 c.c., while that of carcinoma yielded from 10 to 70 mg. Smithies believes that the Wolff-Junghans reaction is of decided value, but its value is very much enhanced when the **fractional technique** given here is followed (Jour. Amer. Med. Assoc., lxiv, p. 1737, 1915):—

Specimens are collected by means of the fractional tube at fifteen-minute intervals. One c.c. of the filtered juice is diluted with 9 c.c. of water; 5 c.c. of this is again added to 5 c.c. of distilled water, and the dilutions are kept up until a series is obtained representing 1:10, 1:20, 1:40, 1:80, 1:160, 1:320, 1:640 or more. Then they are stratified with approximately 1 c.c. of the Wolff phosphotungstic acid reagent. Readings are immediately made and the tube giving a ring at greatest dilution recorded.

The **glycyltryptophan** and **tryptophan tests**, in the light of recent

communications from our laboratory (Spencer, Meyer, Rehfuß, and Hawk: Amer. Jour. of Physiol., 1916) and others, seem valueless.

Blood is found in about 75 per cent. of cases, by the fractional technique in a larger proportion, and with about equal frequency in the stools.

Lactic acid found regularly in the stomach in 35 cases of gastric cancer. Sarcinae were observed in 3. In a case of renal carcinoma there was considerable lactic acid in the sound stomach. The symptoms had long pointed to this organ; a simple gastric ulcer was found. Rodella (Corresp. f. Schweiz. Aerzte, June 1, 1918).

The *Abderhalden reaction* cannot be depended upon for diagnosis. Von Dungern (Münch. med. Woch., xxvi, 1380, 1913) employed the method of *complement deviation*; Waelli (Mitt. a. d. Grenzgeb. d. Med. u. Chir., xxv, 184, 1912) the *antitrypsin reaction*, which has been further elaborated by Roux and Savignac (Archives des mal. de l'App. Digest., vi, 453, 1912), etc.; but none of these has been satisfactory. The *anaphylactic reaction* of Kanschoff (Jour. Amer. Med. Assoc., lvii, 103, 1911; lxi, 8, 1913), the *meiotagmin reaction* of Ascoli (Münch. med. Woch., lvii, 63, 1910), the *hemolytic test* of Kelling (Archiv f. Verdauungsk., xviii, 164, 329, 1912), the *cytolytic test* of Freund and Kaniner (Biochem. Zeitsch., xxvi, 312, 1910; xlv, 470, 1913), the *hemolytic reactions* of Crile, Fischel, Fränkel, the *skin reaction* of Elsberg, Neuhof, and Geist have all been recommended, but none of them has proven to be specific or infallible. The estimation of *colloidal nitrogen*, *neutral sulphur*, and the determination of the *oxyproteic acids* have been suggested as *urinary tests*, but the same criticism, namely, their non-specificity, renders them unfit as diagnostic tests.

X-ray Examination.—By means of careful fluoroscopic and serial radiography it has been possible to determine gastric neoplasm in its incipency. This method reveals the form, size, and position of the organ, and,

as Bécclère was accustomed to say, gives a "moulage" or cast of it. Carcinoma interferes with gastric peristalsis, causes "defects" in the gastric image, and frequently can produce shrinkage or fixation of the whole organ. In advanced carcinoma the picture is characteristic by its moth-eaten appearance in the medullary and adenocarcinomatous types or its shrinkage and irregular canalization in the scirrhus types. Early carcinoma may produce merely a persistent pocket or "filling defect" in the image, which is with difficulty distinguished from ulcer or spasm. The possibility of defects due to extragastric pressure or adhesions must be constantly borne in mind. Achylia with advanced scirrhus cancer and complete narrowing of the pylorus and antrum, will frequently produce the picture of patulous pylorus and rapid evacuation, while the opposite form, a large stenosing carcinoma of the antrum or pylorus due to medullary or adenocarcinoma will be found accompanied by gastric dilatation. The combined fluoroscopic and plate method is of the greatest value and when the former is combined with manual palpation under the screen much can be elicited. The visualization of the palpable tumor and the coincidence of the filling defect with it are convincing findings.

TREATMENT.—The treatment alone offering positive cure is **surgical removal**. Surgery itself has its limitations, but *the gravest danger of all is late diagnosis*. This is due primarily to consulting the physician only after the disease has been fully developed, secondarily to the physician who fails to insist on a **thorough study of the case**.

Operation gives no hope of successful completion if (1) the tumor crowds well up in the cardia; (2) if the cardia is obstructed; (3) if the growth is diffuse and the organ shrunk; (4) if there is extensive glandular involvement; (5) if there is involvement of other organs, as the pancreas, liver, or colon; (6) if foci, such as the rectal shelf and ovaries, be transplanted, and (7) extreme cachexia must be considered (Graham). There is prospect of a 5-year cure in 25 per cent. and a three-year cure in 41 per cent. (Mayo). Surgery's chief contribution is thus prolongation in life, although cures are also met with. The operative mortality of a resection is about 10 per cent.

Medically in inoperable cases, where motility is still intact, the problem before us is essentially one of a proper diet and measures to prevent, as far as possible, infection of the ulcerated neoplasm while trying to relieve symptoms. The diet should be **highly nutritious**, finely divided, **and**, as far as possible, **predigested**. Vegetables, in purée form, finely chopped meats, soufflés, peptonized milk, starchy foods which have been dextrinized, and an **avoidance of all coarse, irritating foods** and of all but finely emulsified fats—as we want foods which rapidly leave the stomach—are the proper dietetic measures.

Gastric lavage and the use of **antiseptics** and **alkaline cleansing agents** locally are often of much value, while instillation of **silver salts** will often help control secondary infection.

The use of the **Coley toxins** or the **split protein vaccine of Vaughn** (N. Y. Med. Jour., Oct. 15, 1910) suggests itself, as well as the various

forms of **colloidal therapy**, but as yet no satisfactory treatment has been devised. **Radium** locally and deep **X-ray** therapy confer little benefit. The greatest good comes from attention to details care of the mouth and throat, regulation of the diet, prevention of intestinal infection, and insurance of regular bowel evacuation. **Lavage** and **bitter tonics** for anorexia; **orthoform**, **anesthesin**, **spirits of chloroform** for pain, or even the use of **analgesics** in suppository form; **cerium oxalate**, **sodium bicarbonate**, **bismuth subcarbonate**, **magnesium oxide** for burning and discomfort; **mineral oil**, **cascara**, **phenolphthalein**, **extract of belladonna** and **magnesia** as laxatives, or **colonic irrigations** for obstinate constipation, are all in order. If stenosis occurs, **surgical relief** is indicated.

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STOMACH, DISEASES OF.—GASTRIC NEUROSES.—**Synonyms.**—Nervous Dyspepsia, Dyspepsia, Indigestion, Flatulency, Weak Stomach, etc.

General Considerations.—True neurosis of the digestive canal occurs chiefly in subjects between the 20th and 40th years of life and with about equal frequency in the two sexes.

Its general causes are disorders due to abnormal nutritive states of the nervous system, and developing, *e.g.*, from insufficient food, low vitality, physical or mental overwork, or a general abnormal catabolism. Added to these are toxic causes and instability of the psychic make-up.

NEUROTIC SECRETORY CONDITIONS.

HYPERACIDITY.—Hyperacidity

is a symptom of some form of irritative disorder. This may be an ulcer, Reichmann's disease, etc. But sometimes the condition is a pure neurosis.

Etiology.—Hyperacidity is found in the young and middle-aged, less often in the old. The following factors are important in its production. First: Indiscretions in diet, *e.g.*, the use of irritating, excessively bulky foods, large meals, the abuse of alcohol, tea and coffee, and particularly that of tobacco; hasty eating; drinking of excessively hot or cold fluids or carbonated beverages, particularly with the meals; eating of foods too highly seasoned or with essential oils, and the use of an excessive amount of candy. Second: Disturbances of the gastric secretory apparatus due to mental strain, overwork, anxiety, worry, hysteria, neurasthenia, melancholia, and psychic conditions. Any sudden mental shock may bring on low or absent secretion or motility, and when mental strain is long continued, the opposite may occur in the secretion, the motility at the same time remaining normal or even being depressed.

As to whether primary myasthenia or atonic states of the stomach should be considered causes of hyperacidity, I have doubts. But there is a form of hyperacidity secondary to chronic constipation, and likewise there are symptomatic hyperacidities due to open, more or less healed, or irritative scars from acute or chronic ulcer; early gastric cancer, cholelithiasis, pancreatic or renal calculi, acute hepatitis, a mild degree of acute gastritis, gastritis acidæ, chlorosis, etc.

Symptoms.—Whatever the cause, the symptoms are, as a rule, the same:

Eruptions of acid gas or regurgitations of acid food or fluid (sometimes termed *pyrosis*), heartburn, pain and burning in the stomach and cardiac region, severe stomach pressure, distress one or more hours after meals (relieved by foods or alkalies, made worse by starches), attacks of nausea, and perhaps occasional vomiting during the height of gastric digestion, the return burning the throat and benumbing the teeth as it passes over them, thirst or an excessive flow of saliva, constipation, anorexia, malaise, headache, loss of weight and strength, and finally the development of neurasthenic states. The neurotic form is usually abrupt in onset, and relief on taking foods or alkalies, or when the stomach is empty, is marked. Where there is a dietetic or neurological cause, recurring attacks, with intervals of relief, may be present. In the secondary forms, on the other hand, with the exception of duodenal ulcer, this history of intermission is not common.

Diagnosis.—This is made from the symptoms, the discovery of a cause, and the analysis of test meals. The physical examination is usually negative, though mild anemia may be observed. In some, however, there is epigastric tenderness. Diminution in the chlorides and increase in indican are frequently observed in the urine.

Considering only the neurotic and dietetic types, the bulk of return from an Ewald meal is increased. The total amount may be as high as 120 c.c., with a high acidity, usually above 30° of combined HCl. A normal stomach should not give an acidity above 30°, and a total return not above 90 c.c.). Poor digestion of the starch content of the test meal, an

empty stomach two hours after a simple test meal, and an alkaline or neutral stomach when it is empty of food, are other features of hyperacidity.

In the digestive form, while there may be no food in the stomach between meals, a little fluid content of an acid nature may continue from one meal to the next. The morning empty stomach in these cases is usually neutral or has only the slightest acidity. During the attacks the mucus content may be elevated slightly, but, as a rule, it is normal, and often below normal.

Prognosis.—Upon removal of the cause at least 90 per cent. of these cases become symptom-free.

Treatment.—The main indications are to control the hyperesthesia of the stomach and to give sufficient food to maintain an equilibrium; or, if necessary, cause an addition in nutrition. Combining the free acidity by proteins is really unimportant. Use simple fluid or **semisolid foods**, hyperesthesia being thus minimized, and a high caloric value in small bulks maintained. Small meals of about equal size and strictly regular, frequent feeding should be ordered. Eggs, fresh milk and cream, well-cooked cereals, bread and crackers, together with a considerable quantity of butter, soft vegetables, minced meat, etc., answer to good purpose. After a few weeks additions to the diet can be made, and at this time **lime-water or alkaline drinks** such as **Vichy, Congress Hathorne, or Carlsbad** may answer.

Hygienic, physical and hydropathic measures should not be neglected. The overworked should be ordered to **rest**, and those who have been under

a mental strain sent to the country, seashore, or mountains. Out-door life and physical exercise are most beneficial. Walking to the place of business and home again, with an additional walk in the evenings, renders this possible to the business man. With women, less carriage and car riding, fewer social functions and theaters, and more exercise and open-air life, are important factors in the treatment. Gastric lavage is malpractice. In patients susceptible to it, electricity is helpful for a short time, and, the condition persisting, intra-gastric galvanism with the positive pole internal; or, if results are not thus obtained, the negative pole internal, is helpful. When atony or marked constipation exists, the faradic current with slow interruptions or the sinusoidal current is best employed. In neurasthenia high frequency to the spine has served a good purpose. The morning cold plunge or sponge bath, or the morning rub with a cold wet towel, are serviceable, and a hot douche before retiring may relieve the insomnia.

For a long time the alkalis have been used to control the subjective distress. Positive and almost immediate benefit comes from their use, and no harm follows their use for long periods. As a rule they should be administered after taking food, when symptoms develop (from one to three hours after meals).

For hyperchlorhydria:—

R. Magnesii oxidi,
Bismuthi subcarbonatis,
Sodii bicarbonatis,
Sodii carbonatis exsiccati,
Sacchari lactisāā ʒiiss (10 Gm.).

Fiat pulvis.

Sig.: Take ½ teaspoonful in water one, two, or three hours after meals.

When constipation exists:—

R. Magnesii oxidiʒiiss (10 Gm.).
Mistura rhei et sodæ. ʒvij (200 Gm.).

M. Sig.: Take a tablespoonful (as required in time) after meals, in water.

Or, when a powder or mixture is not desired:—

R. Magnesii oxidi,
Bismuthi subcarbonatis,
Pulveris rheiāā ʒvj (24 Gm.).

Fiant tabellæ no. L.

Sig.: Take 1 or 2 tablets (as required in time) after meals.

The second drug of importance, which is of particular value in a persistent case, is belladonna or atropine. This drug effectually inhibits gastric secretion, but its unpleasant physiological effects may require discontinuance. Tablets or pills of extract of belladonna ¼ grain (0.016 Gm.) or atropine sulphate ⅓ grain (0.00065 Gm.) may be taken after meals, or one of these may be added to any of the foregoing alkaline combinations.

Nerve sedatives such as the bromides, valerianates and sumbul are most valuable to control the hyperesthesia commonly present in these cases. Its symptoms are most pronounced when irritation from free hydrochloric acid takes place; hence the importance of a suitable diet. A useful prescription is the following:—

R. Sodii bromidi,
Tinctura valerianæ,
Fl. ext. sumbulāā ʒiv (16 c.c.).
Syrupiq. s. ʒiij (90 c.c.).

M. Sig.: Take a teaspoonful, after meals, in water.

Olive oil and other hydrocarbons have been highly recommended, the former especially by Cohnheim. Its use in tablespoonful quantities, swallowed before meals, is sufficient. The oil coats the interior of the stomach

and inhibits the secretion of acid. In those not nauseated by it, its use is worth while, particularly since it is a good reconstructive in the undernourished, and may keep the bowels regular. Addition of salt to the olive oil should not be allowed.

A morning dose of **Carlsbad salts** in a glass of **warm water** is an excellent measure. This neutralizes the acidity present and also moves the bowels, and when given well-diluted in water it acts as an internal lavage of the stomach. The Carlsbad salts can also be used in small doses—15 grains (1 Gm.)—in Vichy after meals.

SUBACIDITY AND ANACIDITY.—In subacidity there is a low secretion of hydrochloric acid, with or without a lowering of the enzyme content. In anacidity hydrochloric acid is absent, but the enzymes present. In achylia neither is present.

Etiology.—In instances of prolonged anxiety, worry or suspense the secretory functions of the stomach are usually inhibited or absent, and but very rarely run hyperacid. The effects of these emotions must be taken into consideration and not too much significance attached to test meals removed under these conditions (or on the first day of menstruation). There is, however, a neurotic subacidity in which the acid and also often the other constituents of the gastric secretion are lessened in a more continuous way. While some of these cases are psychic or mental, most of them are due to debility from long-standing unhygienic conditions, anemia, neurasthenia, hysteria, Graves's disease, tabes dorsalis, and long-standing diarrhea from any cause. Subacidity is also a most

constant finding in chronic gastritis, in early cancer, and in febrile conditions in general. In persons past the 50th year of life there is a marked tendency to diminution of gastric secretions. Some people, moreover, have always had a subacidity or absence of HCl without ever experiencing any symptoms therefrom.

Symptoms.—These vary greatly. Epigastric pressure before and after meals, but usually more marked after them, with fullness, eructations, anorexia, diarrhea, intestinal disturbances, occasionally nausea, headaches, and great nervousness are the most common.

Diagnosis.—The chief factor in diagnosis is test-meal analysis. In subacidity the dimethylamidoazo solution or paper shows only a faint reddish tinge; the Ginsburg test is also low. In anacidity or nervous achylia, abnormal organic acids, such as lactic, acetic, and butyric are met with. No case of nervous achylia should be diagnosed on the Töpfer method alone. The Hayem-Winter method of estimating total chlorides and the tests for the enzymotic power must also be applied. Further, the diminution or absence of HCl and enzyme must not be noted at every examination of test meals (and several should be extracted); if they are, one is probably dealing with a more serious state of affairs.

Prognosis.—This depends upon the removal of the causative condition, which is usually possible. Where the condition is of long standing the treatment may require some months.

Treatment.—In the acute nervous cases the removal of the cause, sedative symptomatic treatment, and general directions regarding diet, state of

health, etc., answer all purposes. A change of environment is often sufficient. When the condition persists, it may be necessary to allow only enough proteins as will combine with the hydrochloric acid present, or, in its absence, a less amount, in finely divided form—just enough to maintain nutrition. Important are the use of foods that are finely divided and the liberal employment of well-cooked carbohydrates. When the ability to digest meat is deficient, substitution of brains, sweetbreads, etc., may answer. Milk, as a rule, is not very well borne. Of the liquids, broths, such as rice, chicken and barley, as well as albuminous drinks and raw or soft-boiled eggs, are recommended. Peas, beans, and lentils in purée form or broths are useful. Potatoes, rice, tapioca, sago, and farina, well-cooked in water or dilute milk, are well borne; likewise, any of the breads, rolls, simple cake, or crackers, and a little butter.

Intragastric faradism may be used when gastric motility is impaired.

The drug treatment comprises substitution therapy and also an attempt to improve secretion.

Permanent results may be obtained in achylia by lavage of the stomach, its disinfection if need be, and the giving at intervals of fifteen to thirty minutes of 60 c.c. (2 ounces) of 0.25 per cent. hydrochloric acid for several hours. After several such treatments a full meal is taken and followed at once by another fractional instillation of acid. Parathyroid extract also serves in obscure cases. M. E. Reh fuss (Jour. Amer. Med. Assoc., Oct. 20, 1917).

Meat, broths, extracts, gelatin and peptones stimulate the gastric secretion, and in the neurotic forms of the acute type this property may be

remedially utilized. In the more persistent type these substances are irritating, and small amounts of alcohol in the form of Byrrh wine and Dubonnet before meals answer better. Bitter tonics may be used. In other instances dilute hydrochloric acid answers best, though in the persistent case its use may prove irritating. Where this is the case, one may either resort to dietetic means, or disregard the deficiency of secretion and render the gastric digestion alkaline, considering the organ as a part of the intestine and confining its function to that of a receptacle for food. In such instances the following serves well:—

R *Pancreatini* ʒiiss (10 Gm.).
Sodu bicarbonatis ʒv (20 Gm.).

Fiant pulveres no. xx.

Sig.: Take 1, after meals, in water.

For anorexia there is no better treatment than insisting upon taking sufficient quantities of food, together with the use of tincture of *nux vomica*, 15 minims (1 c.c.), well diluted before meals. In anemia high feeding should be kept up, and in the non-acid tolerant cases the non-astringent forms of iron given, and in the acid-tolerant cases the stronger forms of iron. Of the latter, the tincture of ferric chloride is most effective, particularly when kidney complications exist:—

R *Tinctura nucis vomica*. ʒij (8 c.c.).
Tinctura ferri chlorid.. ʒiiss (10 c.c.).
Syrupi ʒiij (90 c.c.).

M. Sig.: Take 1 teaspoonful well diluted in water one-half hour after meals.

Rhubarb or cascara may be used in constipation. Flushings, either by rectum or after appendicostomy, are preferable in cases of gastro-enteric atrophy with marked secondary or pernicious anemia. When no atony

exists, the use of the sodium chloride waters, such as Kissingen, Weisbaden, and Homburg, is sometimes of value.

HETEROCHYLIA.—This term applies to an alternating state of secretion occurring chiefly in "nervous dyspepsia." At different times within a short period the stomach analyses show a subacidity and hyperacidity, or, more commonly, an acidity and hyperacidity. The condition is of nervous origin, the vagus or sympathetic innervation being mainly affected. Among the symptoms are anorexia and a sense of weight and fullness in the stomach when the acid is low or absent, and eructations when it is high. It may be impossible to tell if a low or high level of secretion exists at the time. The elements of myasthenia, neurasthenia, and hysteria are marked in these cases.

Treatment.—This is mainly hygienic and climatic, with **high protein feedings**. One should remember that the gastric condition is secondary, not primary.

GASTROMYXORRHEA.—The increase of mucous flow may occur at intervals (intermittent gastromyxorrhoea), or, much more frequently, be constant (continuous gastromyxorrhoea). The condition is more common than is supposed.

Etiology.—Küttner believes that in the acute form there is some connection between disorder of the nose and that of the stomach. The chronic form may accompany subacidity or anacidity, or various organic diseases, or may exist independently. It is assumed that the mucus is derived mainly from the glands of the pyloric region.

Symptoms.—In the intermittent cases a short prodrome of headache, nausea, and anorexia, usually in the mornings for one or two days, is noted. An attack of severe intractable vomiting follows, the vomitus consisting of large amounts of tough, slimy mucus, finally mixed with bile and intestinal juices. As a rule no pain is present, but prostration may be marked. Such an attack may last from a few hours to several days, ending suddenly. In the chronic form subjective symptoms are usually absent or insignificant.

Diagnosis.—This is possible only by aspiration of the fasting stomach during an attack. Care must be taken to distinguish mucus swallowed from that of the stomach.

Treatment.—In the acute form, during a paroxysm, thorough **lavage of the stomach** with an alkaline solution may terminate the symptoms at once. Later on it is useless. A hypodermic injection of **morphine**, as well as **external** applications of **heat**, may be called for. Interval treatment consists in gradually ascending doses of **nux vomica** until physiological effects are produced, then continued for some time at a smaller dose. Should paroxysms be frequent, **belladonna** in fair-sized doses during the day, or one rather large dose at bedtime, is helpful. Tonics and hygienic and climatic measures may be indicated.

In the continuous cases no treatment is more efficient than morning and evening lavage with an alkaline fluid, followed by a solution of fluid-extract of **hydrastis**. **Nux vomica** and **belladonna** may also be used, but the effort should be made to diagnose a more primary pathological state

(e.g., chronic gastritis), to which the treatment should subsequently correspond as well as to the general condition.

NEUROTIC SENSORY DISTURBANCES.

HYPERESTHESIA GASTRICA.

—Here the gastric mucosa is hyper-sensitive even to normal stomach contents. The simplest forms of food or drink will often cause distress, though normal secretion and motility be present. In many instances, particularly in the Semitic races, distress is more or less continuous, though intensified by food. The condition accompanies practically all of the primary stomach disorders and many of the secondary disorders as well. It may be looked upon merely as a symptom. In neurotics subacidity may be present, or the stomach secretion may vary.

Etiology.—As a primary affection hyperesthesia is found in cases of long-standing dietetic indiscretion, neurasthenia, and hysteria, anemia, general debility and mental strain, in sexual excesses, and after the use of stimulating fluids and narcotic drugs. It is found oftener in females than males, the disproportion being greatest in the younger adult years.

Symptoms.—Mild pain (severe pains are gastralgic), fullness, and weight or pressure appear immediately after or are made worse upon taking food or drink. Nausea or even vomiting may take place at the height of the distress. The very cold and strong or carbonated drinks, may cause more distress than solid foods. The patient fears to partake of sufficient food, thus may lose weight and become anemic. Symptoms of hyperchlorhydria may be present.

Diagnosis.—Test meals may be negative, and the diagnosis is made from the symptoms, history, and relief through proper treatment. In persistent cases all local and general conditions must be excluded before diagnosing a primary hyperesthesia.

Treatment.—According to many the patient should be put to bed and a milk or egg-albumin diet ordered. I agree with this for the severe cases and with Rosenheim, to an extent, for the anemic ones. In general, however, among patients intelligent enough and with strength of purpose enough to follow directions, only a small proportion need go to bed.

According to the history of dietetic causes obtained, abuse, habits, etc., must be stopped. The diet is essentially that described under hyperchlorhydria. In a few cases, even with great and persistent dietetic care, the symptoms do not abate. In such, pathological conditions of the stomach or other organs must be persistently searched for. Especially confusing is an underlying obscure form of myasthenia or neurasthenia. There are cases with subacidity of the stomach which, nevertheless, do best on the **alkalies**. In some instances a little experimenting is necessary to determine whether an acid or alkaline treatment is wisest. High caloric foods and **iron** are always in order in the anemic and undernourished. Drugs answering best to control distress are the **bromides**, and it is not unusual to have to employ one of these salts in large doses for weeks at a time:—

*R. Sodii bromidi ... ℥iiss-vj (10-24 Gm).
Aque menth. pip. ℥viii (240 c.c.).*

M. Sig.: Take a tablespoonful in water after meals.

Or:—

R Sodii bromidi,

Tinctura valerianæ 3iiss (10 c.c.).

Aqua chloroformi f3iij (90 c.c.).

M. Sig.: Take a tablespoonful in water after meals.

Or, when constipation exists:—

R Tinctura rhei,

Tinctura valerianæ 3iiss (10 c.c.).

M. Sig.: Take 20 drops in water after meals.

Useful also in any of these cases are the **hygienic** and **hydrotherapeutic measures**, cold compresses to the **abdomen**, **galvanism**, occasionally the use of **nux vomica** in small doses, **belladonna**, and a **sojourn** in the **country** away from work.

GASTRALGIA NERVOSA.—This is an intense form of gastric hyperesthesia in which the paroxysms are periodic or spasmodic. They soon subside, an interval of complete health following. There is a question as to whether gastralgia is an entity; yet it comprises about 2 per cent. of all the cases of neurosis.

Etiology.—It is probably due to a sensory disturbance of the gastric vagus terminal branches. The most frequent causes are excessive indulgence in tobacco, irregular eating, too free use of cheap soda-water, drinking of iced fluids in excess, and the use of very stimulating foods and fluids.

Symptoms.—The attacks of pain or spasm appear quite suddenly, although they may be preceded for a few hours or days by anorexia, headache or backache, vertigo, fullness and weight in the stomach, slight precordial or gastric pain, nausea, and perhaps vomiting. In the majority of cases the history is not obtained unless definite questions are

asked, and even then may be denied altogether. In a few months, suffering from pain or spasm is extreme. The pain is situated in the epigastric and left and right lower chest and hypochondriac regions. From this the pain may radiate into the left chest, left shoulder, back or general abdomen, and may be so intense as to cause weakness and collapse. The patient is usually anxious and in an attitude affording the greatest relief. Usually the stomach region is tympanitic. There may be tenderness and a sense of relief on steady pressure. The attack lasts from a few minutes to several hours.

Diagnosis.—This is based on the history, symptoms, type of individual, and brief seizures. In recurring cases, ulcer, hypersecretion, gastromyxorrhœa, cardiac or pyloric spasm, biliary or renal colic, intercostal neuralgia and herpes zoster of the lower left dorsal nerves, and angina abdominis must be excluded.

Treatment.—The treatment is that of hyperesthesia gastrica together with, unless a true neurosis, care of the underlying condition. During the attack, hypodermic injection of **morphine** with **atropine** may be necessary. **Hot compresses** may be applied, and in the less severe cases the **bromide** mixtures already mentioned may suffice. **Chloral hydrate** by mouth or rectum answers well when the seizure is prolonged. **Foods and drinks** should be **withheld**. **Strychnine** for a few days may be necessary to strengthen the patient. In the true neurotic form, treatment in the interval is most important. **Tobacco** and **alcohol** must be **interdicted**, **regular eating habits** advised, and the taking of cold drinks, soda water, tea, coffee,

and strongly stimulating foods, be stopped. General tonics, good food, regular living, a long period of rest in bed each day, fresh air, outdoor exercise, massage, and hydrotherapeutic measures are in order. When there is an underlying cause recovery is slow.

NEURASTHENIA GASTRICA.

POLYSYMPTOMATIC NEUROSIS OR NERVOUS DYSPEPSIA.

—This condition is a mixed neurosis in which the sensory, secretory, and motor nervous mechanisms of the stomach, either in combination or alternately, play a part. The disturbance is essentially a neurasthenia affecting chiefly the stomach, and with it commonly the small intestine (gastroenteric neurasthenia). Strictly speaking, this type of disorder excludes the true sensory neuroses and the high and low secretory and motor conditions already described. It is only as one views the patients from a neurasthenic standpoint, and after a large number of gastric analyses, that these cases of true neurasthenia gastrica can be distinguished.

Etiology.—Any of the factors that chronically deplete the general tone of the body—constitutional diseases, unhygienic conditions, dietetic errors, or other factors—may so affect gastric digestion as to cause neurasthenic variations in its function, *i.e.*, variations sensory, secretory, and motor, not necessarily coexisting, but at least all present at different times within a short period (within seven days). Neurasthenia gastrica comprises only about 10 or 15 per cent. of the cases of functional gastric disorder. It is commoner in the male sex than in the female.

Symptoms.—General neurasthenic states are characterized by a morbid irritability and fatigue of the physical and psychical processes accompanied by various sensory disturbances, including such symptoms as depression, morbid thoughts, lack of power of attention, fullness and throbbing in the head, occipital headaches, insomnia, pains and tender areas along the spine, nocturnal emissions, dread of impotence, hot and cold flashes, localized sweatings, transient blueness, cardiac pains, and irregular, rapid, or slow heart action.

Among gastrointestinal symptoms, the chief are those of the sensory group coming on after meals, *viz.*, weight, fullness, ill-defined gastric, sternal, or back pains, burning or cold feeling in the stomach, and an empty sensation in the stomach even after a large repast. As a rule, these are not dependent upon the quality or quantity of food ingested, but rather upon the state of the emotions and the body as a whole. Sometimes the most digestible foods cause distress, while the most indigestible are borne without discomfort. To the above list of symptoms may be added heartburn, eructations of inodorous and tasteless gas, sitophobia, digestive vertigo, and the intestinal symptoms of distention, abnormal sensations, flatulency, and constipation. There may be thin, long stools at one time and normally shaped stools at another. The appetite is usually capricious. Examination of the abdomen is often negative, but tender zones may be noted, as well as gas distentions in the cecum, colon or sigmoid. Chronic excessive putrefaction in the intestines is a common factor.

Diagnosis.—This is based on the incongruity and inconsistency of the gastrointestinal symptoms, and the frequent combination of cerebrospinal and vasomotor disturbances with them, on the variable course of the illness during observation, on the length of time required for recovery, and on the stomach analyses. The greater the gastrointestinal symptoms, and the fewer, relatively, those of the general system, the more certain it is to be a case of true neurasthenia gastrica. To establish the diagnosis practically every other gastric condition must be excluded. The cases of ulcer, gastritis, prolapse; a constantly high, low, or absent secretion; increased or absent mucus; atony, or hypersensitiveness, must all be relegated to pathological states other than neurasthenia, although in the latter any or all of these conditions may be present only for a short time. In so far as gastric analyses are concerned, a more or less constant variation in gastric secretion, motility, and sensation, is alone diagnostic. Cases in which gastrointestinal or corporeal symptoms are intense and persistent, but numerous analyses prove normal, are seldom those of clean-cut neurasthenia. A diagnostic feature of general neurasthenia is the observation that, even if there is a variation in the amounts of hydrochloric acid secreted at different times, the ferments are more often present in about constantly even amounts. The secretion of enzyme is much more independent of general conditions than that of the acid, and when it is influenced, this is to be taken as evidence of a local condition.

Prognosis.—This, as a rule, is good if the exciting cause can be removed,

general strength built up, and treatment continued long enough. The milder forms yield readily to treatment, most of them requiring about a year of observation when in the cities, and possibly half that time in sanatorium treatment in the country. Many patients, handicapped from birth with a weak, nervous system, only do well when no especial demands are made upon them. Phlegmatic individuals with more or less visceroptosis may continue over long periods in fair health, but may easily progress on a downward path, lose flesh and strength rapidly, and have relapses on the least provocation. All of these cases require strong persuasion to have them carry out the essentials of treatment. The confidence of the patient must be gained, and assurance given that he will later get well.

Treatment.—In all cases presenting some other ailments these should receive first attention. The patient must be made to feel that hygienic measures are all-important. **Change of climate, entire relief from business and perhaps social life, abundant food, outdoor exercise, fresh air,** but not too much sunshine, **regular living, sufficient sleep, and hydrotherapeutic measures** are essential. General body **massage** and **electricity** in any form are valuable adjuncts. No attempts at dieting are indicated; in fact, the rule should be to give large amounts of high caloric foods, irrespective of the symptoms. **Tea, coffee, alcohol,** and the **stimulating foods** should be **interdicted**, but the taking of **supplemental meals** should be encouraged. The **gastric douche** may be employed, but no direct benefit to the stomach comes from lavage un-

less gastric hypomotility exists. The **ferruginous** or **arsenical waters** may be taken when indicated, or **iron** may be given. The **bromides** are necessary at first to control the symptoms, but **valerian** and **nux vomica** bring about the best results in the end. **Nux vomica**, combined with the **elixir of gentian** with **tincture of iron chloride** (elixir gentianæ cum tinctura ferri chloridi, N. F.; dose, 1 fluidram—4 c.c.), taken diluted before meals, answers best for the anorexia. The bowels may be kept open by dietetic means, **cascara**, **phenolphthalein**, or **enemas**, but the purgative waters should not be used. There should be taken each day at least 4 glassfuls of water (1 warm before breakfast); **fruits**, morning and evening; the liberal use of **honey**, **butter**, and **olive oil** or **fresh cream** should be encouraged; a dish of **stewed prunes**, sweetened with lactose, should be eaten before retiring; the use of **bran gems** at meals instead of bread, rolls, or cake, should be advised. **Agar-agar** may be taken with milk or cream and sugar, with or in place of the morning cereal. Habit-forming drugs should not, as a rule, be employed in neurasthenia. A prescription of value is, however, the following:—

R Fluidextracti cocæ,

Tinct. nucis vomicæ...āā f3ij (8 c.c.).

Ac. phosphorici dil.... f3vj (24 c.c.).

Syrupi zingiberis f3iss (45 c.c.).

Aq. menth. pip..q. s. ad f3vj (180 c.c.).

Ft. mist. Sig.: Tablespoonful in water after meals.

BULIMIA.—This is characterized by an abnormal feeling of hunger. It may be the only manifestation of a primary neurotic condition, or be associated with dilatation of the stomach, neurasthenia, hysteria, tape-

worm, pancreatic and intestinal affections, brain tumors, Basedow's disease, pulmonary tuberculosis, diabetes, syphilis, etc. It is probably due to contractions of the muscularis of the pyloric region. Neurotic bulimia may occur in periodical attacks, at times accompanied by faintness, tinnitus, vertigo, headache, trembling, and cold extremities. As a rule secretion and motility are normal. **Treatment for the neurotic condition**, small meals at hourly intervals and large doses of **bromides**, are helpful. In persistent cases, a primary cause other than neurosis should be carefully sought.

PAROREXIA.—This designates perversions of appetite, and includes (1) **pica**, a desire for articles of a non-food character, such as coal, ashes, earth, chalk, insects, etc.; (2) **malacia**, for special or pungent foods, such as vinegar, mustard, sauces, catsup, green fruits, etc.; (3) **allotriophagia**, a desire for disgusting or harmful foods, such as urine, feces, glass, needles, pins, knife-blades, etc. Pica and malacia are often observed in the same individual in neurasthenia, and allotriophagia is noted in hysteria, idiocy, and lunacy. Malacia is often met with in chlorotic girls and pregnant women.

POLYPHAGIA.—In this condition excessive amounts of food are required to satisfy the hunger. It is found mostly in chronically dilated or large stomachs, viz., in certain females of the very slim type. It differs from bulimia, in that there is satiety after the meal. It may be primary (neurotic) or symptomatic, paroxysmal or permanent, and the treatment for the neurotic form is as for bulimia.

AKORIA.—This is a term used to distinguish a slight disturbance from bulimia and polyphagia, in that the appetite may not be increased and may even be diminished. It is treated in the same manner.

GASTRALGOKENOSIS.—This is a neurosis characterized by the appearance of pain in the stomach when it is empty, and its disappearance as soon as food is taken. It occurs oftenest in hyperacidity and hypersecretion. It is probably an expression of hyperesthesia, and relief is easily procured. Thorough **purging** is advisable.

ANOREXIA NERVOSA. — (See under the heading, ANOREXIA NERVOSA, vol. ii).

NAUSEA NERVOSA.—A purely functional form of nausea, occurring in neurasthenia, hysteria, psychasthenia, debilitated states, etc. When associated with neurasthenia or hysteria it is very intractable, and **isolation** is advisable. In other nervous cases, in which the condition is less pronounced, the patients should be **encouraged to eat or drink** as they please, the nausea being controlled with general **sedative drugs**. **Bitter tonics** as well as general tonics should also be given. Where vertigo, trembling, and vasomotor disturbances coexist, persistency, full control of the patient, and complete confidence on his part are likewise essential to success.

SITOPHOBIA.—A condition of hyperesthesia, associated with the fear of food, and in which, if the condition continues, dyspeptic symptoms greatly increase after the taking of the smallest amounts of food. It is a symptom of gastric hyperesthesia and is similarly treated. The patient

should make every effort to take nourishment, even though it produces distress. Sometimes a rest in bed is helpful. When there is an associated hyperchlorhydria this should be treated with **alkalies** and diet.

DISTURBANCES OF GASTRIC MOTILITY.—These may be divided into 3 groups: Those of slight degree, mostly functional in type (*myasthenia gastrica*), those of more marked extent in which peristaltic power is distinctly deficient (*gastric atony*), and those in which the power of the organ is markedly assailed to the extent of enlargement (*gastric dilatation*).

MYASTHENIA GASTRICA AND GASTRIC ATONY.—Myasthenia gastrica (hypomotility) is present when there is a slight delay in the exit of foods. The stomach is usually normal in size, but may be slightly enlarged, though no difference in the thickness of the walls is to be observed. Gastric atony is usually accompanied with secretory deficiency as well, and the organ is considerably enlarged and the walls distinctly thinned. Atony will be described under Secondary Ectasia.

Etiology.—Mechanical stretching stimulates smooth muscle. When an organ with walls of smooth muscle is flaccid and toneless, distention calls forth no response, and this is true in the atonic stomach and colon. In general body weakness the secondary nervous system may be unable to maintain tonus. Acute mental states have a powerful influence on motility and secretion, and general debility acts similarly in a more chronic way. Added to these causes are: Habitual consumption of indigestible foods or fluids; excessive gas collection in the

stomach, such as is met with in neurotic disturbances, gastritis, malignant diseases, and states of reduced acid and enzymotic secretion; congenital structural and vital deficiencies, and primary diseases, such as gastric ulcer, perigastric adhesions, splachnoptosia, chronic gastritis, chronic constipation, and states of excessive intestinal fermentation.

Symptoms and Diagnosis.—In myasthenia gastrica there are no definite symptoms or signs. The diagnosis may be made with reasonable certainty in those who have had digestive disturbances following a long period of mental strain, and who show a low state of gastric secretion; in dietetic cases which have for years gone on with improper methods of feeding and gradually developed digestive symptoms; in those in whom hyperesthesia and excessive secretions are excluded, in whom test-meals and motility tests show only slight retardation or are negative; in cases in which gas collection in the stomach has long existed, with the tests for primary conditions negative; and in those in which dyspeptic disturbances accompany constitutional disorders or disorders of the central nervous system, intestine, gall-bladder, generative organs, or heart.

The diagnosis of true primary atony is much more definite. Here one can take advantage of the meal analyses, and figure on the solid and fluid returns. A moderate degree of stagnation or retardation is observed. The returns from the Ewald meal show larger quantities of solid and fluid contents than normal, not separating into the characteristic three layers seen in secondary ectasia, and free of yeast spores, sarcinae, Boas-

Oppler bacilli, lactic acid, and blood. The fluid contains a normal total amount (not relative proportion of a small amount of filtrate) of hydrochloric acid and enzyme, and perhaps a hyperacidity in the early stages.

For the methods of test-meal analysis and estimation of gastric motility the reader is referred to the Index-Supplement volume.

The X-ray method of diagnosis is of no value in myasthenia, and of questionable value in atony. The best way to investigate gastric evacuation here is by test-meal examination. In the X-ray procedure the fluid bismuth mixture leaves the stomach more readily than food, and one is often misled. The subjective symptoms are: Loss of appetite or a feeling of satiety from the smallest amount of food; distress in the stomach after meals, lasting for from one to four hours; greater distress on taking fluids than solid foods; pyrosis, nausea, regurgitation, but rarely continued vomiting; belching of either tasteless or odorless gas or that tainted with the taste of foods taken hours previously; constipation, headache, vertigo, nervous symptoms of various kinds, palpitation of the heart and indefinite cardiac pains, difficult breathing, and, in the forms secondary to nervous or constitutional disorders, sometimes a ravenous appetite. *Gastric vertigo* (vertige stomacal) is often a distinctive feature. In myasthenia gastrica the physical examination of the stomach is generally negative. In atonic ectasia it is enlarged and lax, the greater curvature in the prone position reaching to the umbilicus or below in the males and always below in the females. The shape as well as the size

of the organ should be mapped out, so that an atony will not be diagnosed gastroptosis; however, more or less atony is generally present with the latter. On inflation, the stomach can easily be mapped out by percussion or auscultatory percussion. Splashing or succussion sounds are most valuable to diagnosis, particularly when present some hours after a full meal. Water may be given and the splash noted, but it is only when the splash is loud and easily produced that the sign is of any value. If the abdominal wall is very thin and relaxed, the borders of the stomach may be indistinctly palpable or visible. Gastrodiaaphany may be employed, but the X-ray-bismuth or hourly X-ray-food methods answer better. These patients are usually poorly nourished, and when young are anemic.

Atonic ectasia must be differentiated from secondary ectasia, gastroptosis, certain nervous disorders of the stomach, neurasthenia, megagastria, and chronic gastritis.

Prognosis.—Simple myasthenia usually corrects itself when the local and general conditions of the body are improved. Atonic ectasia is essentially chronic, though its course depends largely upon a sustained treatment, the recuperative power, and the results of treatment of an underlying condition when present. Often the most gratifying results are obtained where gastroptosis coexists. Atony may pass into definite relaxation, but this is rare. When it does occur, the prognosis is bad.

Treatment.—Where constitutional and infectious diseases are contributory, close supervision is required in convalescence. Injudicious and rapid

eating, poor mastication; excessive use of fluids, tea, coffee, alcohol, and tobacco; incorrect modes of life, and the habitual use of purgatives, must be corrected. The patients require a general mixed diet and **superalimentation** by frequent or supplemental feedings. Not much attention need be given to the status of secretion unless this is markedly hyperacid. In this event, the diet for excessive secretion should be instituted. When the symptoms are relieved, the diet should be as dry as possible, only such fluid being allowed as will allay the thirst. The best foods are the various meats, poultry, game, fish, eggs, cream, butter, peas, beans, lentils, and well-cooked, mashed or strained vegetables. If milk is well borne, four glassfuls a day should be allowed, re-enforced with fresh cream. The cereals can be taken, but fruits, berries, and green vegetables are not safe. Cocoa or chocolate made with milk should be substituted for other beverages, and all gaseous or alcoholic fluids should be avoided. **Olive oil** may be employed, and foods suggested for constipation often serve well. The simple cheeses may be taken, but never the pungent forms. The caloric value of the day's diet should always be above 2500, and later in the treatment preferably close to 3500 calories. The food should be cut very fine and well chewed. The diet is essentially that for gastroptosis.

Lavage should never be practised unless there is a definite indication for its use, such as chronic gastritis. If apparatus and technique are good, **gastric douching** may be of benefit, but collection of water in the stomach must be guarded against; either cold

or quite warm water may be used. **Intragastric faradism** with slow vibrations, or the sinusoidal currents, are valuable adjuncts. The external electrode method may also be used. When distress is marked the galvanic current is the best to tone up the muscle-walls. An apparatus delivering faradic and galvanic currents at once answers to good purpose. *Séances* should last from ten to fifteen minutes; the faradic current should be used to tolerance and stronger on the back than the front, and the galvanic current at from 10 to 25 milliamperes. From 15 to 20 treatments, at the rate of two or three a week, are sufficient. After this, in cases with constipation, the colon may be treated with the currents, or electric vibration or massage added to the routine. Good hygiene and a strengthening *régime* are advisable. In some cases **systematic exercise** benefits, *e.g.*, games such as handball, squash, boxing, fencing, tennis, and golf. The **morning sponge** or **cold rub** is serviceable. Patients should not do too much brainwork or be too much confined indoors. Women who have primary atony and become pregnant should be watched very closely, kept in bed three or four weeks after labor, nourished very well, bandaged properly, exercised to strengthen the abdominal muscles, and watched during lactation. When patients can afford it, a midsummer and midwinter vacation is advisable.

Strychnine or **nux vomica** should be given throughout the treatment and in the largest doses tolerated. **Belladonna** or the oils can be used for hypersecretion, but not sodium bicarbonate. The bowels are kept open by the diet, **enemata**, **cascara**,

or **phenolphthalein**. Anemia is best treated by **dietetic means** and non-astringent forms of iron. **Valerian** is of service when the neurotic symptoms are marked. It is best not to use the bromides. A good prescription when the atony is accompanied by anorexia and neurosis is:—

R *Tinctura nucis vomica*,
Tinctura valeriana,
Fluidextracti conduran-
goââ 3iiss (10 c.c.).

M. Sig.: Take $\frac{1}{2}$ teaspoonful (30 drops) in water after meals.

SECONDARY GASTRIC DILATATION.—This condition is due to mechanical obstruction in the pyloric region. There is an acute dilatation of extreme degree that results in rare cases from the drinking of large amounts of fluids, but this is only a temporary condition. Postoperative gastric dilatation will be described in the next section.

Etiology.—The degree of stagnation produced in mechanical obstruction is never seen in extreme primary atony, even when the musculature is degenerated or when it has been penetrated by advanced malignant disease. The pylorus or the pyloric region distal and proximal to it may be constricted from within or without. Among the internal causes of constriction are the cicatrices of more or less healed ulcers; malignant disease; continued pylorospasm; hypertrophic pyloric stenosis; foreign bodies, such as rosin balls, hair balls, cherry or peach stones; pedunculated benign tumors, and kinking of the prolapsed organ at the duodenal anchorage. Among the external causes may be mentioned perigastric bands stretching across or drawing upon the organ, as may be seen after ulcer,

gastritis, and cholelithiasis; omental adhesions from appendicitis, liver, and infective gall-bladder conditions; pancreatic cysts pressing upon the duodenum; movable kidney, particularly after unsuccessful anchorage operations; floating spleen pressing upon the duodenum; dermoids, and enlarged glands or masses below an indurated ulcer, generally in the posterior wall away from the pylorus.

Symptoms.—The symptoms are those mentioned under gastric atony, with added malnutrition and other variable manifestations. The feature of the symptoms is that they are more intense. Vomiting, particularly that of the collective or stagnant type, is a feature. Pains are more complained of in secondary ectasia than in the primary forms. Tetany or choreiform movements may exist. There is loss of weight, though where there is still a fair channel of exit nutrition may be called good, particularly after a liquid diet rich in proteins. Even in malignant conditions, where stagnation is not marked, an increase in weight may be accomplished in this way.

Diagnosis.—When emaciation is distinct and stenosis is marked, inspection often discloses peristaltic waves in the stomach running from the costal margin on the left to the median line. Percussion usually shows an enlargement of the organ, in which splashing sounds may be elicited. The X-ray shows a large, globular stomach, with stagnation.

Examination of the stomach contents yields most important results. Examination of the vomitus may or may not. In slight degrees hourly mixed test-meal analyses are essential. In severe grades the large,

dark-gray or brown achylic return, with lactic acid, blood, pus, and long-retained food particles, is significant. A fluid separating into three layers on standing is characteristic of malignant disease. The vomitus may be very fetid, and considerable subjective relief generally follows. In lesser degrees of stenosis, particularly when non-malignant, the hydrochloric acid may be normal in quantity, and the meals show an increased amount of bacteria yielding a more than 2 per cent. gas result (Ewald meal) in the fermentation tests. Five hours after a mixed meal, quantities of red meat-fibers, etc., are obtained. In high degrees of stenosis the morning return, after a mixed meal given the night before, usually contains some food. The simple testing method of Mayo is valuable in this connection. An acid return with food, with or without blood (occult or macroscopic) or mucus, and free of lactic acid and the lactic acid formers, argues in favor of benign stenosis; likewise the presence of many sarcinae. Yeast fungi may be found in either benign or malignant stenosis.

In high degrees of stenosis the urine is diminished in quantity. Some claim an output of 1000 to 1500 cubic centimeters for the mildest cases; 500 to 1000 cubic centimeters for the intermediate, and under 500 cubic centimeters for the severer grades. The urine may be alkaline in ulcer and acid in cancer. Phosphaturia or albuminuria may exist, and acetone and diacetic acid be present. Acetone urines are more common in ulcer than cancer. The blood usually shows an anemia.

The differential diagnosis rests be-

tween atonic ectasia and gastric prolapse, neurasthenia gastrica, and gastric crises; the esophageal conditions, and the various stenoses. Often, in the slight or medium grades, all one can conclude is that a degree of permanent stenosis exists, and that it is necessary for surgery to find out its precise character and source.

Prognosis.—In the early stages of secondary ectasia one should guard against a definite prognosis. These cases should be carefully analyzed and closely watched, and resort made to surgery when improvement does not occur or is not sustained. The minor and medium grades of a benign nature are often most amenable to medical treatment; the severe forms demand surgery. Pylorospasm, gastropnoia, and small perigastric adhesions are essentially medical conditions. Marked cicatricial conditions after ulcer, hypertrophic gastritis with distinct retention, large foreign bodies, pedunculated growths, bands, cysts, etc., generally require surgical intervention.

Treatment.—The **dietetic treatment** consists essentially of that mentioned under the early treatment of hyperchlorhydria, together with that given under Atonic Ectasia, excepting that the foods must always be given in fluid, semifluid, or finely comminuted forms. All foods that give distress, ferment, or on aspiration are found to have remained in the stomach too long must be changed in form or discontinued. Best results are obtained from frequent small meals, about six in a day. Occasional **lavage** assists materially, and **stretching the pylorus** by the Einhorn apparatus may be tried in carefully selected cases. When symptoms of distress

come on acutely after the taking of improper foods, prompt **vomiting**, **lavage**, or withdrawal by means of a **stomach-tube** will relieve them. When such attacks are frequent, **surgical treatment** is indicated. **Rest** in the dorsal **recumbent** or **left-sided position after meals** is helpful. The bowels should be moved by **enemata**. **Olive oil** before meals will occasionally give good results. When the medical treatment proves of little value, **pyloroplasty**, **pylorectomy**, **partial gastrectomy**, or **gastroenterostomy** offer brilliant results in the non-malignant forms of stenosis of gastric origin, and in a few of the malignant ones.

ACUTE POSTOPERATIVE DILATATION OF THE STOMACH AND DUODENUM.

ETIOLOGY.—This is still much a matter of conjecture. The condition may be due to mechanical obstruction of the duodenum by the root of the mesentery and the superior mesenteric vessels, caused by a sinking of the empty intestines into the true pelvis, or may be a functional disturbance due to injury to the nervous apparatus either by traumatism or the effects of anesthetics or toxins. I am inclined to the latter view.

SYMPTOMS AND DIAGNOSIS.—Three-fourths of all cases follow operations on patients between 10 and 40 years of age. No type of operative case is especially prone or exempt, nor is either sex.

The definite gastric symptoms may be most acute; yet markedly dilated stomachs in serious cases may exist without vomiting, pain, tenderness, thirst, or scanty urine—all characteristic symptoms. The onset of the

attack, when severe, is generally sudden. The postoperative course appears normal for a few days, or even two weeks. Suddenly gastric distention occurs, with profuse and persistent vomiting of large amounts of fluid; epigastric and umbilical pain, steady or colicky; epigastric tenderness, and symptoms of collapse. Muscular rigidity is usually absent. The abdomen swells, due to gastric enlargement; the right hypochondrium becomes prominent and the left flattened, and the general gastric tympany on the upper left side shows an enlarged organ, the lower border being below the umbilicus. The transverse measurement of the organ is also increased. Epigastric tympany is usually also observed. On passing a stomach-tube, the size of the organ quickly diminishes. The stomach may be so distended with gas that succussion sounds may not be distinguishable. Visible peristaltic waves may occur, and are most common in the moderate grades untreated for several days. In these, a tube should be passed at once, the return revealing an unaccountably large collection of fluid, at first yellow, then yellowish green or green when regurgitation from the upper part of the small intestine is present, and finally brown with solid particles and a fecal odor when the condition had existed for some hours.

A treacherous type of the condition with the symptoms absent or slight is seen where anorexia and fermentation or intestinal flatulency have been continuously present. Suddenly, for no assignable reason, the countenance becomes dusky or pallid, the face "pinched," and the pulse more rapid and thready. The tem-

perature drops, and the abdomen becomes distended. The right upper abdominal quadrant may be slightly prominent. Succussion sounds are more regularly present, but the pain may not be very definite. As vomiting may not occur, dependence must be placed upon the stomach-tube for diagnosis. In these cases death usually occurs within a few days.

The most favorable cases are those in which the paralysis is incomplete. These are about evenly divided between the postoperative and mixed cases, such as occur in typhoid fever, pneumonia, etc. The onset may be slower and more indistinct, and the abdominal examination virtually negative. The diagnosis is suggested by a sudden obscure unfavorable turn in the case during convalescence. Early resort to the tube saves most of these cases. In my opinion, in these patients the intestines may be mainly affected; general gaseous distention and obstinate constipation are then diagnostic.

Among other symptoms that may be noted in acute gastric dilatation are: Scanty urine, subnormal temperature, general muscular cramps, tetany, hiccup, and delirium. The differential diagnosis must particularly be made from peritonitis, ileus, intestinal obstruction, and perforation.

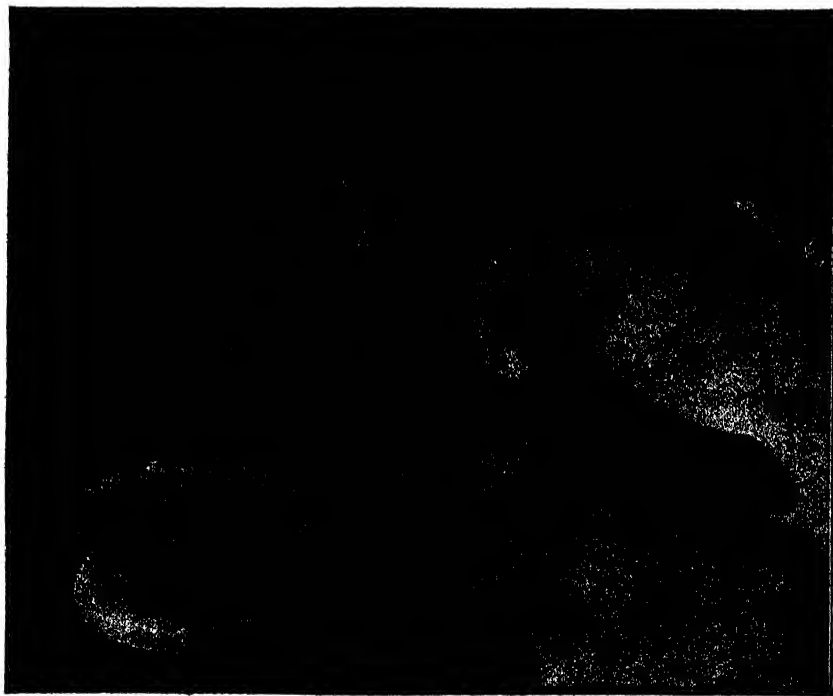
PROGNOSIS.—About 70 per cent. of severe cases with typical symptoms are soon fatal. In the prognosis much reliance should be placed upon the general condition and the diminution of return through the tube. When bile and an absence of gastric enzyme are constantly noted, the prognosis continues grave; when the bile recedes and stomach acids appear, the outlook is favorable.

Should there develop a fecal odor or a return of fecal substance itself intestinal obstruction should be thought of.

TREATMENT.—All foods and fluids should at once be withheld by mouth, stimulation practised, and later **rectal feeding** instituted. In

tinuous drainage of the stomach is a useful and comfortable means to accomplish this, as well as to medicate and later on to feed the patient.

Thirst should be combated by **proctoclysis** or **hypodermoclysis**. Rectal feedings should be kept up until the gastric condition has almost cleared.



Patient with author's continuous drainage stomach-tube in use.

the severe cases with sudden onset, enemas of coffee or other stimulants are first in order. In every case the stomach should at once be emptied, preferably by **lavage** with plain warm water. This should be repeated several times in twenty-four hours—in severe cases, about every three hours. Once every hour or two is not too frequent in the beginning. The lavage should be kept up for several days. The author's method of con-

The bowels should be moved by **enema**, preferably of **saline solution**. **Hot turpentine stupes** may be used to relieve the distention. The best purgative is a single dose of **trituration elaterini**, $\frac{1}{2}$ grain (0.03 Gm.) by mouth, supported by **strychnine injections**. An efficient means to move the bowels and cause discharge of gas is an **enema** of 1 ounce (30 Gm.) of **pulverized alum** in a pint of water. **Atropine** and **strychnine** should be

given hypodermically; the former to relieve possible pylorospasm and control secretion, the latter to overcome the paralysis. The strychnine should be pushed at first—about $\frac{1}{20}$ grain (0.003 Gm.) hypodermically every two or three hours. Giving eserine is malpractice. Lately I have employed **hormonal** in 11 cases, along with other measures, and all recovered. In 2 of the last cases I have used it in, however, no benefit was derived. It is given in $\frac{1}{2}$ -ounce (15 c.c.) doses by deep injection into the gluteals.

The next most important item of treatment is the **postural method**. The half-sitting position, and lying flat with the head of the bed blocked up, have been advised for the dilatation which accompanies pneumonia. These postures relieve pressure in the lower thorax, and thus also the embarrassed heart and dyspnea. In the postoperative cases these postures might increase duodenal obstruction, and elevation of the foot end of the bed has therefore been advised. Others have favored the side position, usually the right, to encourage drainage of the stomach, and some, notably Schnitzler, the prone position (abdomen down). Tight **bandaging of the lower abdomen** or the use of the **Rose bandage**, together with the half-sitting position, might serve to good purpose, but many patients have a laparotomy wound. Of late I have been advising a combination of the two dorsal positions, carried out by blocking up the head of the bed and placing a number of hard pillows under the thorax and head. Two wide boards are next placed in the bed, one extremity resting over the elevated foot end and the other just under the buttocks.

The patient is placed so that the back is bent in the lumbar region, the thorax and head on one side and the hips and lower extremities on the other, being thus elevated at the same time.

Upon subsidence of symptoms milk should be given by mouth in small amounts, preferably peptonized. Later on, the quantity at each feeding can be increased, up to $\frac{1}{2}$ glassful, followed by raw eggs in milk, bouillon, strained gruels, rice, farina, and finally the more solid foods. The **diet** during convalescence must be carefully watched, fatal results having followed too early use of uncooked fruits, meats, etc. Operations have been performed to drain or evacuate the stomach, or relieve the duodenojejunal kink, but these cases do better without operation than with it.

In ileus, fecal material is obtained from the stomach only after several days, and always in small amounts. When, after an operation, symptoms of ileus appear and the returns from the stomach show increasing fecal material, the actual condition is an intestinal obstruction, and for this the indications are to operate at once, withholding food in the mean time and keeping the stomach washed out to minimize the toxic factor.

GASTROPOLYASTHENIA.

—This condition, not described elsewhere, was met with by me in 4 cases in the course of a winter, and is characterized by atony, apparently with hypermotility at the beginning and deficient power at the end of digestion.

Symptoms and Etiology.—At first, rapid emptying of the stomach takes place, due to excessive peristalsis;

later a retardation of food exit occurs, yet the active peristalsis continues.

The third stage presents the usual picture of a moderate degree of stagnation, running five, six, to eight hours after the meal, yet late after the ingestion of food vigorous peristaltic waves are still present, though the food is stagnant. Careful test-meal analyses and X-ray work suggest that the condition is of extra-gastric origin, being probably due to an irregularity of hormone secretion (secretin), with its influence on relaxation of the pylorus.

Diagnosis.—This can only be made with the X-ray. A considerable amount of the bismuth meal escapes within five or ten minutes into the small intestine, some, perhaps, being as far down as the upper ileum. Observing at intervals after this, evacuation of the stomach is noticed to have ceased, although the wild peristaltic waves continue up to six, seven, or eight hours afterward. At this late time, 15 to 40 per cent. of the bismuth meal is still in the stomach, while that which had escaped is well on in the ileocecal region.

The acidity in these stomachs varies. Test-meal analyses do not permit of differentiating the condition from pylorospasm, which it closely simulates. The latter, however, varies at different times, while the motor phenomena of gastropolyas-thenia are identical at each examination of the stomach.

Prognosis.—Under proper treatment the condition is controlled in from one to three months. Care must be taken after that, however, that the diet is suitable, as there is always danger of recurrence.

Treatment.—The subject being usually anemic, debilitated, and nervous, a morning cold bath or shower, or a rub with a coarse towel soaked in cold water, is beneficial. Rest, rather than exercise, is of value. It may be necessary to keep the patient in bed two or three weeks. Arsenic and organic iron preparations are useful. After a time, general massage, with electricity, is of some help.

The diet should be semifluid for the first two or three weeks, consisting of milk, fresh cream, eggs, well-boiled cereals, bread, and butter, to be taken at short intervals during the day,—at least 3000 calories during the twenty-four hours. Later on, bland semisolid and solid foods may be given. Stimulating foods had best be withheld for months. *Nux vomica* in ascending doses is often beneficial. Of much value to relieve the distress quickly is *secretin*, given as an extract of scrapings of the duodenal mucous membrane, either in a solution, powder, or elixir.

CARDIOSPASM.—Normally by cardiac contraction, solids and fluids are momentarily delayed in their passage into the stomach. Abnormally, this spasm may be so pronounced that entrance of food is obstructed.

Etiology.—Cardiospasm may be neurotic or secondary to disease in the lower gullet,—ulcer or carcinoma,—to disease of the stomach, or to disease of one or both lungs, usually the least affected and most often the left. Neurotic, primary cardiospasm is due, in my opinion, to a contraction of the crura of the diaphragm, usually the left. The condition occurs at any age, and, in the majority of instances, in females.



Cardiospasm with Moderate and Uniform Dilatation of the Esophagus.
X-ray by Author.



Same case, taken one-half hour after dilatation of the cardia, showing that there was no delay in the transit of bismuth for it to give a definite shadow of the esophagus. X ray by Author.

Symptoms.—At first the spasm is not sufficient to interfere seriously with the passage of food. At this time there is discomfort and a slight degree of pain, some choking sensation, etc. When esophageal peristalsis is no longer able to overcome the resistance, food accumulates in the gullet and regurgitation takes place. Dilatation of the esophagus soon becomes marked, and there is no regurgitation after meals, but at irregular intervals. In the more pronounced cases there is a substernal sense of oppression and considerable pain, perhaps with dyspnea and a slight increase of the heart's action during the times of stress.

Most patients complain distinctly of a burning, tight, and pressure sensation extending, perhaps, to the lower sternum, together with pains radiating to the back. When dilatation exists relief is felt when the gullet is emptied. Absence of hydrochloric acid and gastric enzyme and persistence of the food in the forms swallowed point to esophageal regurgitations. Even in the benign cases blood may be present, though if this is marked malignant disease or ulceration must be thought of. The second swallowing sound is absent or much delayed, and the sign of Re-widzoff absent. Loss of weight is noticeable in the majority of cases.

Diagnosis.—This is confirmed by obstruction to the passage of the bougie or tube. With the patient in the dorsolateral position, left side down, it can be noted with the X-ray that a swallowed bismuth mixture is retained in the gullet. Radiographs show a markedly dilated gullet incapable of peristaltic waves. At its lower end, a distinct constriction rep-

resenting the contracted cardiac opening is seen. It is rarely more than half an inch long, and differs from the tail noted in malignant disease.

Differential diagnosis is from organic strictures. Use of the esophagoscope may be necessary. In organic strictures there is usually the history of an ulcer or some form of trauma, usually mechanical. Careful sounding with the bougie usually shows these higher in the gullet, mostly in the upper third. Strictures of malignant disease are met with later in life, give a more distinct history of progressive dysphagia, do not have the regurgitation or retention, bleed freely on instrumentation, and show a characteristic X-ray picture.

Prognosis.—This is good provided proper treatment is instituted.

Treatment.—In some of the minor forms attention to the nervous system and general nutrition is alone required. The food should be high in caloric value, and general in character, irritating and bulky foods and drinks being eliminated. **Baths, sufficient rest, regular exercise, and fresh air,** and general **tonics** should be ordered. The bowels should be moved, and any esophageal or gastric condition found suitably treated.

When stenosis is marked, mechanical measures are essential. **Bougies** do not usually suffice. Of the various forms of dilating instruments, the **Plummer dilating apparatus**, while uncomfortable to the patient, is very efficient. A modified form of this consists in using a 20 French esophageal sound, at the lower end of which is fastened a cundum reinforced with silk. To the upper end is attached a length of soft tubing. A syringe of about 150 c.c. capacity

is used to dilate the bag. Water may be used instead of air. Sippy's dilating apparatus also answers.

A majority of cases is entirely cured after one dilatation, providing a Plummer or Sippy apparatus is employed. In the weaker forms of dilating methods several dilatations are necessary.

GASTROSPASM (Pseudo Hour-glass Contraction).—This is probably an unusual form of hypermotility. Characteristic is a history of cramps in the stomach with a tightening sensation in the sternal region and chest, and vague pains in the upper abdomen, chest, and back. Regurgitations of fluid from the stomach, when present, are not noticeably acid. The spasms may come on after meals. As a rule they begin gradually, a final, most severe one, accompanied by nausea, terminating the attack.

Diagnosis.—Distinction from hypermotility and hypersensation can be made only by fluoroscopic examination. The peristaltic waves are deep and active, giving the stomach an ampullar shape, and, perhaps, even a contracted distal feature, suggesting an hour-glass stomach.

Treatment.—This consists of a bland diet, bromides, valerian, hot compresses to the epigastrium, and codeine and chloral in small doses some time before meals. The general condition should be attended to. All irritating foods and fluids, together with tobacco, should be stopped. After a few days recovery occurs.

PYLOROSPASM.—Neurotic pylorospasm is rare, though pylorospasm accompanies many gastric conditions as a complication.

Etiology.—The condition is usually due to some form of irritation.

As a neurosis it may occur at any age, most often in early life. Most apparent cases are due to hyperesthesia of the stomach, hypersecretion, gastric or duodenal ulcer, gall-bladder disease, cancer at the pylorus, and reflex irritation from disease in other abdominal organs.

Symptoms.—At the height of digestion the pylorus suddenly contracts. There is intense pain in the epigastrium, radiating from the median line, with eructations, nausea, and perhaps vomiting, and general symptoms of distress. In almost every case a history of these attacks is obtainable, coming on with long intervals, which finally become shorter and shorter, until, perhaps, almost continuous. Vomiting of foods that had remained in the stomach for some hours may take place. Sharply localized tenderness, corresponding to the pylorus, can be elicited, and perhaps a firm pylorus felt. The general abdomen may be retracted, and gastric tympany is usually pronounced. In the interval a less distinctly localized pyloric tenderness is noted.

Diagnosis.—This is made by the X-ray, the tightened pylorus being observed, together with the condition of retention. If distinct benefit does not follow an intelligent course of treatment, other causes should be carefully sought.

Treatment.—Any primary condition found requires treatment. In the attack a hypodermic injection of morphine and atropine may be given. The diet should be bland,—about that used in hyperchlorhydria. Olive oil before meals answers in some cases; if not, belladonna or atropine after meals aids materially. Occasionally

the bromides in large doses are useful. A formula of value is:—

B. Cadmeæ sulphatis .. gr. ij (0.13 Gm.).
Tincture belladonnae
fokorum fʒj (4.0 c.c.).
Strontii bromidi ʒij (60.0 Gm.).
Syrupi adjuvantis fʒviiij (240.0 c.c.).

M. Sig.: Take a tablespoonful in a little water every four hours.

When the pain is not severe, hot applications or mustard plaster to the epigastrium may suffice. Intragastic galvanism also helps, and, even more, sedatives. Einhorn's apparatus for stretching the pylorus is of value in infants only.

These measures failing, **exploratory operation** should be done. If ulcer, gall-bladder disease, etc., are not found, a **pyloroplasty of the Ferguson type** will cure the case. This operation has practically no mortality, and can be done in a very few minutes.

NERVOUS HYPERMOTILITY.

—Hypermotility not infrequently occurs as a neurosis, not necessarily accompanied by spasm of the orifices or even by gastrosptasm.

Etiology.—The condition is, as a rule, found in those who habitually partake of large amounts of strong soups, coffee, condiments, and rich foods.

Symptoms.—These include anorexia, flatulence and stomach distention after meals, hypersensitiveness to the richer forms of food, and not so much to the simple or to foods in small quantities, postprandial eructations, and looseness of the bowels with gas distention. In some cases only anorexia and a disturbed sensation in the mouth are noted, and the intestinal symptoms predominate, slightly or not at all relieved by thorough purging. The return of a sim-

ple meal at the usual time shows a very small amount with a correspondingly low hydrochloric acid content, or, indeed, the stomach may be empty. Examination at the forty-five-, thirty- and fifteen- minute intervals shows significant gradations in quantity, the largest return being at the fifteen-minute interval. If a mixed meal is used, the stomach is generally empty in two or three hours' time. The X-ray shows an increased peristaltic activity with the formation, usually, of three or more ampullæ.

Diagnosis.—This is made from pyloric incontinence, primary atony, other neurotic states of the gastro-enteron, and the benign intestinal or accessory organ conditions. In long-standing ulcer cases a delay in the exit of foods generally exists.

Prognosis.—In all neurotic cases the prognosis for complete recovery is good, relapses not occurring if the necessary indications are observed.

Treatment.—Simply cooked **solid foods**, free from condiments, are indicated. Soups, broths, tea, coffee, alcohol, and tobacco should be interdicted. In severe cases assumption of the **left lateral position after meals** may be desirable. Lavage, douching, or electricity should never be employed.

The **bromides**, given in large doses, or **codeine**, are useful. Acids usually increase the symptoms, and nuxvomica does not benefit them. **Olive oil** may be given temporarily. Where constipation exists, simple **enemata** are alone indicated. Anemia indicates **ferruginous foods** or non-astringent forms of iron. General **hygienic measures** or a sojourn in the country are best to control an underlying neurosis.

REGURGITATIONS. — Only small quantities are brought up at a time; the stomach is never emptied by the process. Mild degrees (eructations) may occur in hyperchlorhydria, hypersecretion, and chronic gastritis. The neurotic type, generally neurasthenic or hysterical, with normal secretion and motility, is found in not more than 3 per cent. of the cases of distinct gastric neurosis.

Symptoms.—As a rule the onset is gradual, the regurgitations being easily suppressed in the beginning. Certain foods seem to intensify the condition; likewise neurasthenia or debilitated states. The history usually includes rapid eating, and chronic pharyngitis is commonly observed. At length debility may be occasioned.

Prognosis.—This is almost always good, and usually depends upon the results obtained in the treatment of neurasthenia.

Treatment.—The general condition requires first attention, then the neurasthenia and hysteria. The patient must be made to suppress the regurgitations by voluntary control. **Slow eating** and **thorough mastication** should be insisted upon. When the spells are on, **freedom from work** and continued rest should be advised. In severe cases the **rest cure** with isolation may be necessary. **Intra-gastric faradism** is valuable in some instances. The best drugs are **strychnine** and the **bromides**.

R. Strychnina sulphatis gr. ss (0.03 Gm.).

Sodii bromidi ℥v (20.0 Gm.).

Eliziris phosphori .. f℥ij (60.0 c.c.).

Aqua q. s. ad f℥viij (240.0 c.c.).

M. Sig.: Take a tablespoonful, followed by water, fifteen minutes after meals.

MERYCISM. — In merycism, "chewing the cud," or rumination,

foods are regurgitated into the mouth, then reswallowed, perhaps with previous mastication, or primarily ejected. The condition is an acquired one, usually from imitation, and spells mental unbalance or deficiency. It is also seen in the hysterical, and may follow mental shock.

Symptoms.—Merycism may occur in periodical attacks or continue during the whole of life. It begins as a voluntary, pleasurable process, but later is involuntary. The regurgitation continues after a meal until the foods become unpleasant to the taste. If anacidity exists, rumination may continue during the day as long as there is food in the stomach.

The prognosis is good if the patients are anxious to control the condition. Relapses may occur after some mental strain or shock.

Treatment.—The patient must gain **control of the habit**; further treatment is unnecessary in some patients. When this cannot be done an absolutely **fluid diet** should be ordered for a few weeks, to be followed by **slow eating** and **thorough mastication**. **Alkalies** should be used in hyperacidity, and **mineral acids** in low or absent acidity. The **eating of ice** daily after meals has been recommended by Koerner. **Strychnine** and **quinine** after meals are helpful, giving an unpleasant taste to the foods. The **bromides** and **valerianates** serve well. **Intra-gastric electricity** may be efficient in some cases. In neurasthenia and hysteria, with poor general health, the **hygienic**, **hydropathic**, **high-feeding**, and **psychotherapeutic treatments** are necessary. After the rumination is controlled a **sojourn in the country** for several months is of value, particularly when some friend

is present who quickly expresses disgust when the symptom is noticed.

ERUCTATIO NERVOSA (Aërophagia).—This is characterized by attacks of noisy belching of odorless, tasteless gas. It is found in neurasthenia or hysteria, or a result of mental strain or shock. The gases are derived from the bowels, or consist of air previously swallowed (aërophagia). The condition may accompany atony or prolapse of the stomach. The Oser theory of air aspiration, during inspiration, into the stomach, is probably correct.

Symptoms.—The condition persists from a few hours to several days. The patient emits a succession of loud eructative explosions, each manifestation, perhaps, being accompanied by a distressed expression in the face. The attacks are absent during sleep or when the patient's attention is engrossed by some outside matter. The stomach may be very tympanitic.

Diagnosis.—States of fermentation such as accompany gastritis, malignant disease, etc., must be eliminated by test-meal analysis and the X-rays.

Treatment.—The patient must make an effort to control the symptoms. When this is difficult measures for treating the neurasthenia or hysteria are essential. In the long-standing cases the rest cure is required. Electricity to the gullet (faradism) is sometimes useful. The diet should be bland. Large doses of bromides answer well quickly to control the symptoms, valerian serving best for continued treatment. Prolapse or gastric atony must be corrected.

SINGULTUS GASTRICA NERVOSA (Hiccough).—This is rarely met with in a functional nervous form, along with hyperesthesia gas-

trica. Attention was drawn to this form by the writer in 1910. In it continuous hiccough lasting weeks or months, without any return of gastric contents at any time may be seen. It usually occurs in well-nourished young females. Study of two cases showed entire absence of the symptoms of hysteria; and competent neurologists, ophthalmologists, gynecologists, and others, considered these patients normal. In the not uncommon true cases of hysteria in which hiccough is a feature, hysteric manifestations and the appearance of the case render the diagnosis easy. Where doubt exists, local and persistent gastric symptoms and a relatively good health are diagnostically helpful. (See Hiccough, vol. v, page 532.)

VOMITUS NERVOSUS.—Nervous vomiting may occur as a direct or reflex neurosis affecting the vomiting center in the medulla, or may be reflex from affections of the stomach, diaphragm, esophagus, or pharynx. It is not uncommon, and is more frequent in females, constituting about 3 per cent. of the gastric neuroses.

Varieties.—The forms of neurotic vomiting: (1) Cerebrospinal or central, as in meningitis, encephalitis, apoplexy, abscess, cerebral tumors, brain anemia and hyperemia, concussion, intoxication (ether, tobacco, etc.), autointoxications (constipation, indicanuria), septicemia, tabes dorsalis, and transverse myelitis. (2) Functional nervous vomiting, as in the poorly nourished, anemic, and sufferers from mental or physical strain, neurasthenia, and hysteria. (3) Reflex vomiting accompanying various affections of the stomach, eye, pharynx, larynx, middle ear, lungs,

intestines, liver, gall-bladder, kidneys, and generative organs.

The instances of so-called idiopathic vomiting (*vomitus nervosus*) are further divided into (1) psychic vomiting, due to fright, shock, or a sudden mishap; (2) juvenile vomiting, occurring in school-children from overwork; (3) juvenile periodic vomiting, occurring in the infant, and generally passing off after the third year; (4) periodic vomiting of the adult (*von Leyden*), preceded by nausea, gastralgic pain, and headache; and (5) the single attack and persistent nervous form in adults (mostly females), obscure in cause or due to evident general conditions.

Symptoms. — The distinguishing features of the vomiting are the ease with which it takes place, the fact that it is independent of the quality and quantity of food, and the absence of nausea.

In some patients only the fluid ingesta are ejected. Usually the spell is quickly over, and soon after the patient may again take food. In marked cases the skin is dry and the urine scanty. In the periodical form the patient is distressedly ill, and, the vomiting continuing, mucus and bile may be ejected. There may be much abdominal pain, vertigo, weak pulse, and marked constipation. Loss of weight, nervousness, and anemia may be noted in established cases.

Diagnosis.—This is made from the history, general neurotic symptoms, the absence of any positive findings in gastric analyses, reflex causes of the vomiting in other organs, the inefficiency of the usual antiemetic remedies, and the almost magical results from bromides, valerian, and hygienic measures.

Treatment. — One should remove the cause and build up general tone. The psychic form requires merely brief **sedative treatment** for the vomiting.

In periodical and reflex vomiting **absolute rest** should be secured with a single hypodermic injection of **morphine** or a few **opium suppositories**. A **mustard plaster to the epigastrium** and **cold applications to the head** are useful. If vomiting persists, oral, or, better, rectal use of **bromides** and, perhaps, also **chloral hydrate** in solution, is effective. The **swallowing of pieces of ice over which a little brandy has been poured** affords some relief. **Acetylsalicylic acid** is often of service to relieve general distress. On recovery the precise cause should be sought and treated, or, if it cannot be found, a **sojourn in the country** and **hydropathic procedures** advised. When the symptoms are intense food should be withheld for a few hours, and in the interval high caloric feedings maintained.

Persistent cases may be divided into those that improve on ambulatory treatment and those that do not. The mode of life, etc., must be looked into and corrected, according to indications. Mental excitement, worry, anxiety, suspense, late hours, trying work, etc., must be avoided. The patient should be told that vomiting is not important or serious, and that he should always make a direct effort to control it. Special dieting serves no distinct purpose, though **frequent small meals** may be advisable. **Bromides** and **valerian** should be taken regularly in large doses. When the vomiting is controlled they should be continued in reduced dosage for some weeks. **Hydrotherapy** is of benefit,

and **electricity** may be of psychic value. In the more extreme cases a **rest cure** may be essential. **Feeding by gavage** for a period may be helpful. Faradism is most efficient in the bedridden cases. After the bromides, tonics should be given for a period. A **change of occupation** is often effective.

PNEUMATOSIS.—In these cases the stomach is distended with air, expulsion of which seems impossible. Many correspond to the so-called asthma dyspepticum of Henoch, and may be modified forms of *aërophagia*. Other instances are seen in cardiospasm, pylorospasm, atony, dilatation, prolapse, and neurotic conditions. The condition may be periodical or continuous, is more common in males, and is not unusual in individuals of the intellectual type.

Symptoms and Diagnosis.—The epigastrium is protuberant, and the stomach tensely tympanitic. There may be a constant effort to belch without result, a sensation of distention, dyspnea, anxiety, and perhaps collapse. In the continuous form the distention is not so marked. Gastric analysis may show a normal, high, or low acidity.

The diagnosis is made from the history, by exclusion of other gastric conditions in which distention is common, and from cardiac affections.

Treatment.—Prompt passage of the **tube** is indicated. This may have to be repeated. In continued cases the tube may not be required. If a tube is not at hand, the attack may be relieved with an injection of **morphine** (Ewald). Ten drops of **Hoffman's anodyne**, **spirit of peppermint**, or **chloroform spirit** in sweetened hot water, or 5 drops of **turpentine** on a

lump of sugar, may give relief. The routine of treatment comprises that for the underlying neurosis, neurasthenia, or hysteria; for these states **strychnine** or **nux vomica** should be given. Physostigmine and *cannabis indica*, to guard against recurrence, are not as efficient as **bromides**, **codeine**, and **valerianates**.

PERISTALTIC UNREST.—This condition was first described by Kussmaul as a neurosis.

Symptoms.—The most important symptom is the noting of violent visible movements in a stomach free of pyloric obstruction. The waves run downward from the costal margin toward the median line, and seem to be more active than is the rule in pyloric obstruction, in which they are about six in number to the minute. There are often like, though less evident, movements in the intestine, together with more or less loud rumbling and crampy sensations. Eructations, nausea, anorexia, sinking sensations in the stomach, constipation, diarrhea, and symptoms of neurasthenia may also be noted.

Diagnosis.—The stomach may empty itself too quickly or normally. Fluoroscopy with bismuth shows its wild gyrations. The test-meals may show any degree of gastric secretion at the time, but more or less variation in later examinations. Pyloric stenosis must be excluded; this is easily done with the stomach-tube, X-rays, and by observation of the case. Clinical distinction from gastrospeasm is not important; in gastrospeasm the history is more suggestive and peristalsis discernible only with the X-ray.

Treatment.—If a marked or moderate true pyloric stenosis is believed

present the case is an operable one. If not, the neurasthenia must be treated according to its degrees. **Extensive outdoor exercise** at regular hours is of value in the moderate cases. **Retiring early** and **hydrotherapy** are also efficient. Occasionally **intra-gastric faradism** or **stomach lavage**, with rather cool water, answers well. The **diet** should be bland; small meals at regular intervals are best. General **tonics**, or **hematinics** in the anemic, should be given. For the gastric symptoms large doses of **bromides** and **valerian** should be given an hour or so before meals, and the tonics after. **Belladonna** and **codeine** may also be used in selected cases. The bowels must be kept open.

ANTIPERISTALTIC UNREST.

—Cases of this condition are probably identical with peristaltic unrest. They must be differentiated from pyloric or intestinal stenosis and conditions of abdominal prolapse. Small antiperistaltic waves seen with the X-ray running from the pyloric region toward the fundus are indicative of pyloric obstruction. The treatment outlined in peristaltic unrest also answers in these cases.

PYLORIC INCONTINENCE.—

This may arise through pyloric neoplasm or by traction of internal scars or external adhesions. The condition is usually part of a general atony. That it may be neurotic in type is doubtful.

Symptoms and Diagnosis.—There is vague gastric distress, with constipation, insomnia, abdominal distention, and neurasthenic manifestations. The diagnosis is suggested by finding an empty stomach soon after eating, with bile present in the full

as well as the empty organ. On inflation it is said that the air rushes into the intestine, causing a prompt general tympany, the stomach tympany soon disappearing. I agree with Ewald and Einhorn in that this is a fallacious method of examination. Four cases of rapid evacuation and constant presence of bile in the stomach were found by me to be actually instances of hypermotility of the externally invisible form. One should be careful in making the diagnosis of pyloric incontinence from only moderate inflation and test-meal extractions, without further examination.

Treatment.—The use of finely subdivided solid foods, frequent small meals, intra-gastric faradism, strychnine, postural treatment, and measures for neurasthenia are advised.

DUODENAL REGURGITATIONS DUE TO FATTY FOODS.

—Hitherto the cases in which fats or oils have been considered contraindicated have been those of so-called "fat intolerance," with poor fat digestion and absorption. The author has called attention, however, to a stomach condition in which fat foods and the native oils are actually harmful.

Symptoms.—There occurs a sharp attack of acute gastric pains, radiating to the back, paroxysmal, lasting several minutes to several hours, and sometimes for days. They may be severe enough to incapacitate the patient, though when they disappear—often suddenly—he is as well as ever. The gastric distress is independent of meals. Occasionally nausea is associated, but not vomiting. The condition occurs in the middle-aged. The physical examination of the stomach and abdomen is negative. The gastric analyses show a large

return after an Ewald meal, which is deeply bile-stained, contains much floating fat, fatty acids, pancreatic juice, hydrochloric acid, and perhaps mucus from gastric irritation. The empty stomach, aspirated, even in the morning, shows a large accumulation of duodenal secretions, fat and fatty acids, etc. The accumulation is less when the patient is pain free or has been on a fat-free diet.

In the production of the condition it is probable that the fats directly affect the pyloric mucosa and muscle, thereby causing local relaxation or otherwise permitting of regurgitation from the bowel.

The pains are due to accumulation of regurgitated juice, resulting in the formation of fatty acids from the oils and fats, and these with the bile irritating the stomach.

Diagnosis.—The condition must be differentiated from those instances of test-meal extractions, in which a little bile is noted in the stomach from gastrosuccorhea (in which pains are not so severe, little or no duodenal secretions are present, the mucus content lower, and the hydrochloric acid higher), and pylorospasm. The best means of differentiation is gastric analyses, together with aspiration from the fasting stomach.

Treatment.—These cases rapidly recover under a fat-free diet—skimmed milk, white of eggs, carbohydrates, green vegetables, salads, boiled meats, etc.

ACUTE GASTRITIS.—The limits of the various types of acute gastritis, both pathologically and clinically, are very elastic, and, further, one has difficulty in feeling sure that what looks like acute gastritis may not be an exacerbation of chronic gastritis.

ACUTE CATARRHAL GASTRITIS (Simple Gastritis, Acute Indigestion).—Etiology.

The predisposing causes include the acute fevers; the metabolic disorders; low nutritive states, such as debility, anemia, and the blood dyscrasias; and chronic congestion of the stomach due to heart, liver, or kidney disease. The exciting cause is overeating, eating when physically tired, or when mentally depressed or excited; unsuitable food; foods unripe, improperly cooked, or tainted, *e.g.*, ptomaine-bearing ice-cream, fish, and meats; alcoholic overindulgence; taking a large amount of very hot or very cold fluid; and irritating drugs, such as quinine, metallic salts, acids and alkalies, iodides, and salicylates. Trauma of the upper abdomen may rarely precipitate an acute gastritis.

The male sex is that more frequently affected. The condition occurs at all ages. Most cases are seen in the summer and fall, due probably to unripe or overripe fruit, excessive use of ice-water and alcoholic fluids, or food tainted during hot weather.

Pathology.—The mucous membrane is swollen and flat, or may be mottled. Usually tenacious mucus clings to the surface. Submucous hemorrhages may be observed, and small erosions are not uncommon in the pyloric region. The histological changes in the mucosa are usually marked, sometimes out of all proportion to the intensity of the symptoms. The gastric cells are swollen, and the interglandular substance may be injected with polynuclear leucocytes. Portions of the columnar epithelium may be absent. Many of the acids as well as the central cells do not show

nuclei, displaying merely a loose granular protoplasm. The upper portions of the gland tubules may be missing. Bacteria are commonly found, usually the *B. lactis aerogenes*, *B. coli communis*, *B. proteus vulgaris*, *Oidium albicans*, and streptococci.

Symptoms.—These vary greatly in severity. The onset is usually acute, following a manifest indiscretion in diet. Heaviness or fullness in the epigastrium is experienced. After ejection of gases, brief relief is obtained, which may be followed by distress greater than before. Distinct nausea may be present and, in those who vomit easily, the stomach contents may be ejected, after which the relief of symptoms is marked. In the milder cases the gastric distress runs along for an hour or two, and then, without vomiting, gradually subsides.

In the severe forms acute pains may occur, radiating to the hypochondriac and sternal regions. There may be severe headache, a moderate rise in temperature, anorexia, regurgitation of sour or bitter gastric contents, marked thirst, cardiac palpitation, giddiness, frequent vomiting, restlessness, and profuse sweating.

If the vomiting continues when the stomach has been emptied of food, the vomitus consists of saliva, mucus, bile, and even blood. Ejected foods show absence of digestion. Together with the lactic and butyric acids found, acetic acid is sometimes easily recognizable in those who have drunk alcohol. Hydrochloric acid is generally absent. The abdomen appears bloated and the stomach markedly tympanitic and tender. Constipation usually exists, though diarrhea may follow the attack. The

tongue is coated. Herpes, urticaria, or erythema may appear, especially when tainted fish and shellfish have been responsible. The urine is high colored. Excess of indican is the rule when vomiting has not occurred and the bowels remain constipated. Fever, present in about half the cases, may reach 105° F. (40.6° C.), and be preceded or accompanied with a chill or chilly sensations. The catarrhal inflammation may extend to the duodenum and, obstructing the gall-duct, lead to jaundice.

In gastritis due to toxic foods, vomiting is incessant and prostration marked, with small, rapid pulse, clammy skin, a blanched countenance, and apathy.

Generally an attack of gastritis lasts from one to four days. If neglected or frequently repeated, it may pass gradually into the subacute or chronic form. In ptomaine-poisoning, where prostration is marked, the patient is apt to die. The same is true in acute gastritis occurring in middle-aged or old persons late in the course of long-standing disease. A few cases in children also end fatally.

Diagnosis.—This is readily made when a cause is apparent and acute gastric distress and fever are present. Absence or marked reduction of hydrochloric acid in the vomitus, the presence of organic acids, and the undigested food, are significant. Slowly developing febrile forms with slight gastric symptoms may be temporarily confounded with incipient typhoid fever; the rapid course and the absence of typhoid symptoms and Widal reaction soon remove doubt.

Many infectious diseases begin with a history of acute gastritis. Therefore in all cases with high

fever, when the cause is obscure, one should be guarded until the time for pathognomonic symptoms of other diseases has passed. The temperature in acute gastritis rises sharply and then falls uninterruptedly to normal. Herpes labialis speaks in favor of acute gastritis, though it may also occur in malaria and pneumonia.

Acute exacerbations of chronic gall-bladder and duct disease, or cholelithiasis, not causing much pain or any icterus, may be mistaken for acute gastritis.

Treatment.—If spontaneous vomiting does not occur, and the stomach is distended with gas and food, it should be emptied, especially when distress persists, and in ptomaine cases. **Gastric lavage** is the best procedure. A hypodermic injection of **apomorphine**, $\frac{1}{20}$ grain (0.003 Gm.), may be given in sthenic cases. In mild cases 1 or 2 glassfuls of **hot water** may relieve the distress, either by promoting vomiting or washing the stomach contents into the intestines. A little table **salt** or **English mustard** added to the water should be the only emetic measure applied per os. Ewald and Boas, however, recommended the following:—

R *Pulv. ipecacuanhæ*. gr. xxij (1.5 Gm.).
Antimonii et potas-
sii tartaratis gr. ʒi (0.05 Gm.).

Pone in chartulam no. j.

Sig.: To be taken at once or in divided doses.

To children **syrup of ipecac** may be given in a teaspoonful dose, or, better, 20 drops every 10 minutes until vomiting occurs.

All food should be withheld for some time. Later, fluids such as strained barley, rice- or albumin-water, or weak tea, may be employed.

Solid foods should not be allowed until the demand for them is rather insistent. About the third day, thin soups, soft-boiled eggs, toast, bread and butter, oysters, etc., may be given, and, if well borne, supplemented by meats on the next day. Ordinary diet may then be resumed.

Marked local distress calls for a **mustard plaster on the epigastrium**, immediately followed by an **ice-bag**. **Turpentine fomentations** may be used for distention in the subacute stage. A purgative should be given after the stomach has become tolerant—preferably **calomel**, never oil or salines. Ewald's plan of giving calomel in two doses of 6 grains (0.4 Gm.) each, one hour apart, is far preferable to the giving of small divided doses. Laxative measures had best be withheld until about thirty-six hours after the beginning of the attack.

Antipyretic drugs should not be given in acute gastritis. For pain and general distress, a small dose of **morphine**, or, better, **codeine**, given hypodermically, is helpful, but counter-irritation and hydropathic measures should first be tried. The following suppositories are useful:—

R *Codeinæ sulphatis* .. gr. v (0.3 Gm.).
Extracti belladonnæ
follorum gr. ss (0.03 Gm.).
Olei theobromatis ... q. s.

Fiant suppositoria no. x.

Sig.: One every hour until relieved, then discontinue.

For vomiting, which persists after evacuation of the stomach, **bismuth** or **cerium oxalate** are of use, e.g.:—

R *Bismuthi subnitratiss* ... ʒiiss (6 Gm.).
Cerii oxalatis ʒss (2 Gm.).
Peppermint-sugar ʒj (4 Gm.).

Pone in chartulas no. x.

Sig.: Take 1 powder every hour until vomiting is controlled.

A little **brandy** or **cracked ice** **internally**, or a **mustard plaster** to the **gastric region**, sometimes controls the vomiting sufficiently.

Symptoms of hyperacidity, or pyrosis with thirst, indicate use of the **alkalies**. **Lime-water on ice** may be employed, or the following:—

R Magnesii oxidi,
Sodii bicarbonatis,
Bismuthi subcarbonatis,
Peppermint-sugar ...ââ 3j (8 Gm.).

Fac in pulverem.

Sig.: Take ½ teaspoonful in water every three hours.

For pronounced prostration, the usual sustaining measures should be applied. In ptomaine-poisoning cases **gastric lavage** and an **enema** are indicated; if the patient is seen somewhat late, **croton oil** or **colonic enemata**, should follow the lavage. Such cases not infrequently go into extreme collapse and imperatively require hypodermic injections of **strychnine**, **nitroglycerin**, **ether**, **camphor**, **whisky**, or the hypodermic preparations of **digitalis**. These may be used in rapid succession without danger of overstimulation.

For the anorexia, aversion to food, and physical weakness that may persist after acute gastritis, the following tonic is useful:—

R Strychnina sulphatis, gr. ¼ (0.05 Gm.).
Ac. hydrochlorici dil. 3j 30.0 c.c.).
Elixir gentiana, q.
 s. ad 3iv (120.0 c.c.).
 Fiat mist.

Sig.: Take 1 teaspoonful in ½ glassful of water before meals, through a glass tube.

ACUTE SUPPURATIVE GASTRITIS (Phlegmonous Gastritis, Gastric Abscess).—Etiology.—This may be primary or occur as a complication of other gastric affections, such as stomach cancer and the gas-

tric involvement of typhoid fever, puerperal fever, pyemia, variola, anthrax, severe exanthemata, and articular rheumatism. As a primary affection the disease is rare, and occurs either in the diffuse infiltrative or the rather localized form of gastric abscess. The condition is generally fatal. It is usually met with in laborers in late middle life and of the alcoholic type. It is caused by entrance into the submucosa of a virulent organism, usually the *Streptococcus pyogenes*, sometimes the staphylococcus, colon bacillus or pneumococcus.

Pathology.—In the diffuse form the pyloric region is mostly involved, being swollen, boggy, and pale yellow. The stomach-wall shows a marked infiltration with pus-cells, leucocytes, serum, fibrin, micrococci, endothelial cells, lymphocytes, and eosinophilic leucocytes. This infiltration usually extends throughout the interglandular tissue, causing small ulcerations through which the pus wells up. The muscularis shows fatty degeneration, and the peritoneum may be raised from it by inflammatory exudate. Areas of congestion in the gastric region, a collection of cloudy fluid in the peritoneal cavity, congestion of the pancreas, pus in the pleural and pericardial sacs, pneumonia, nephritis, and purulent meningitis are other possible accompaniments.

Symptoms.—Intense burning pain in the gastric region, not increased by pressure or change of position, is suddenly experienced. With it come extreme thirst, a dry tongue, and an obstinate fever of 103° F. to 105° F. (39.5° to 41° C.), sometimes preceded by a chill. The pulse becomes small, rapid, then irregular. Restlessness

and distress are soon followed by delirium. Retching is generally present. The vomitus, where vomiting occurs, consists mainly of mucus and bile, with pus-cells, many bacteria of one type, and blood-cells. Constipation is soon followed by diarrhea. In a few hours prostration and coma ensue. Perforation may occur, or the case runs a subacute course for one or two weeks. If a large abscess occurs, it may be palpable externally.

Diagnosis.—The presence in the vomitus of numerous bacteria of the same type is a good diagnostic indication. If rupture of an abscess into the stomach occurs, pus is easily seen in the gastric contents or vomitus. Where it is absent, the diagnosis rests upon the bacteria, pain, vomiting, meteorism, fever, diarrhea, and general phenomena of serious illness. According to Ewald, the condition may closely mimic abscess of the spleen or left hepatic lobe. When localized swelling is noted, aspiration, or, better, an exploratory incision, may be justified; where physical signs are indefinite or fever lacking, the diagnosis cannot be made during life.

Treatment.—**Lavage of the stomach** with a 1:10,000 **corrosive sublimate solution** or one made from $\frac{1}{2}$ ounce (15 Gm.) of **boric acid** to a quart (liter) of water is an appropriate measure. **Opium** in large doses may be used, together with **ice-cold applications to the abdomen**, and, when collapse occurs, **strychnine**, **ether**, **camphor**, etc. **Iced champagne** or **brandy** may be of some benefit. Should localized abscesses occur, **drainage** is in order. Recovery is rarely reported, though localized abscesses, rupturing into the stomach,

might drain sufficiently to permit of spontaneous recovery.

INFECTIOUS GASTRITIS.—

This is due to non-pyogenic bacteria, worms or fungi. The diphtheria and anthrax bacilli, the favus, thrush, and yeast fungi, and animal parasites such as the larvæ of diptera (maggots) may be responsible, rarely ascarides and tapeworms.

The symptoms are those of severe acute gastritis with fever, lasting one or two weeks. The condition may be mistaken for typhoid fever.

The treatment is chiefly expectant. **Lavage** and small doses of **calomel** are generally of benefit. If intestinal worms in the stomach are suspected, their removal should be secured.

TOXIC GASTRITIS.—**Etiology.**

—This is an intense form of gastritis produced by poisons such as phenol, potassium cyanide, mercury bichloride, arsenic, antimony, chloroform, oxalic acid, the mineral acids, and the caustic alkalis in strong solutions. Strong solutions of alcohol and ammonia and croton oil may also be included.

Pathology.—Non-corrosive poisons cause intense hyperemia and tumefaction with desquamative changes in the glandularis. The mucosa becomes swollen, superficially necrotic, and hemorrhagic in spots. Corrosive substances cause a more general necrosis, possibly with perforation.

Symptoms.—Intense burning pain, epigastric, sternal, and oral, usually soon follows ingestion of the poison. Marked tenderness in the stomach region develops. Incessant vomiting soon begins and, by increasing the pain, may cause syncope. The vomitus contains mucus, blood, and sometimes shreds of mucosa. Thirst is

great, and a thin, bloody diarrhea is often noted. Dysphagia is common. Severe general symptoms follow, which may end in collapse. Hematogenous jaundice, petechiæ, albuminuria, and hematuria may be noted. The temperature may reach to 104° F. (40° C.), and life be spared long enough for a fatal nephritis to develop. Death may follow in a few hours or a few days from collapse, or later from perforation peritonitis. Stenosis of the esophagus, cardia, or pylorus, or atrophy of the oral and gastric mucosa may ensue with subsequent inanition.

Diagnosis.—This is usually made by cross-examination of the patient or by the history obtained from those nearby. Gastric symptoms and examination of the mouth, throat, or vomitus, are also helpful. Chemical examination of the gastric contents and urine may be necessary.

Treatment.—It is necessary first to ascertain the poison taken. If the case is seen early, the **stomach** should be **washed out** with warm water containing some demulcent and a little of the appropriate antidote. In cases seen later, **siphonage of the stomach** is preferable, to reduce the chances of perforation. A soft tube is safer and more satisfactory than the Kussmaul pump.

Antidotes.—Caustic alkalis: dilute **vegetable acids**, **lemon- and lime-juice**, or **vinegar**. Antimony: **tannin** in **demulcent drinks**. Arsenic: **sesquioxide of iron**, made by adding carbonate of sodium to tincture of ferric chloride, or dialyzed iron. Phenol: **alcohol**, solution of **magnesium** or **sodium sulphate**, dilute **sulphuric acid**, or **saccharated solution of lime**. Hydrocyanic acid: 2

drams (8 Gm.) of **magnesia** in water, followed by 15 minims (1 c.c.) of **ferric chloride** and 12 grains (0.8 Gm.) of **ferrous sulphate** in aqueous solution. Iodine: **starch-water**. Mercurial salts: **white of egg and flour**. Oxalic acid: **lime or magnesia**. Phosphorus: **magnesium sulphate**. The use of **olive oil** or **molten vaselin** in the stomach, after neutralization and lavage, diminishes the effect of the corrosive poisons, except phosphorus.

Morphine may be used to control the pain and general distress, **bismuth** and **cracked ice** to allay irritation, and an **ice-bag** externally in peritonitis. Oral feeding should not be permitted until recovery is well established, nutrition being meanwhile maintained by **rectal enemata** alone. Prostration and collapse indicate the ordinary prompt stimulation.

CHRONIC GASTRITIS.—This is a condition due to organic gastric changes, the term not necessarily applying to any gastric case simply because it runs a chronic or subacute course. The misleading and inaccurate terms "catarrh of the stomach" and "chronic dyspepsia," sometimes used as synonyms for chronic gastritis, should be abandoned.

Varieties.—Severe cases of chronic gastritis may, for clinical and therapeutic purposes, be divided into two types—the sthenic and asthenic. The former are those associated with increased secretion of hydrochloric acid and gastric enzymes, and sometimes increased motility; the latter, those in which these functions are diminished or absent. Pathologically, there are three main types: Simple chronic gastritis, in which the glandular elements are mostly affected; the hypertrophic or sclerosing form, where in

addition the connective tissue and musculature are proliferated (*benign cirrhosis of the stomach*), and the atrophic form, showing loss of epithelium, destruction of the glands, and sometimes more or less growth of connective tissue. Primary and secondary types of chronic gastritis are also distinguished. The former are due to unsuitable foods, alcohol, tobacco, abuse of purgatives, etc. The latter are the result of acute gastritis plus continued indiscretion, or represent complications of other gastric or general affections.

Etiology.—Chronic gastritis is a common disease, occurring in all stations and ages of life, and oftener in men than in women. In primary cases it is caused by continued dietetic errors, including the use of foods defective in quality or preparation, rapid eating, alcohol, etc. Tea, coffee, and tobacco in excess are additional factors, and likewise over-indulgence in carbohydrates and fats. Two or more causes often coexist.

Rapid eating and overeating, continued use of overseasoned foods, and the alcoholic or iced drinks are the most common causes. Among those using the lighter wines at their meals chronic gastritis is not as common as in those who take whisky or liqueurs, carbonated wines such as champagne, sparkling Moselle, or alcoholic fluids containing much carbohydrate, such as beer and ale. Moderate alcohol drinking is often associated with dietetic error, and the condition is common in persons well nourished and leading a steady, regular life in other respects.

Among other conditions that may directly start a chronic gastritis are an incompletely resolved acute gas-

tritis, typhoid fever, and an unhealthy oral condition.

As a secondary disorder chronic gastritis occurs in gastric cancer, ulcer, atony, and long-standing neurotic secretory and motor disturbances. It also accompanies anemia, chlorosis, leukemia, chronic tuberculosis, Addison's and Bright's diseases, gout, nephritis, diabetes, syphilis, and amyloid disease. Again, it may result from chronic engorgement, as in hepatic cirrhosis, chronic heart and some chronic lung affections, and Banti's disease. It may accompany or result from almost any subacute or chronic disorder causing debility.

PATHOLOGY.—In *simple chronic gastritis*, the stomach is usually slightly enlarged, the mucosa gray, in parts reddish, and mucus covered. At the pyloric end, usually most affected, the mucosa may be found rough and mammillated. While usually thickened, it may be thin and firm. Microscopic study shows a parenchymatous and interstitial inflammation of the glandularis and, in long-standing cases, infiltration of the submucosa, and perhaps some hypertrophy or atrophy of the muscularis. The cells typically show mucoid and also usually fatty degeneration. In true simple chronic gastritis only the upper cells of the tubules may be affected. The veins are usually enlarged, and small areas of hemorrhage may be noted near the pylorus.

Hypertrophic and sclerosing gastritis represent more advanced conditions. Hypertrophic changes in the connective tissue about and below the glands may cause the mucosa to be thrown up in ridges, locally or more diffusely. When the submucosa is involved, as is usual, the glandu-

laris becomes more firmly fixed to the inner muscular coat. The resulting interference with circulation in digestion, together with the more or less complete destruction of the gland cells, causes absence or decrease of gastric-juice secretion in these cases.

In still more advanced conditions, sclerotic thinning of all the gastric coats may ensue (phthisis ventriculi or complete atrophic gastritis), or an enormous thickening may occur, due to hypertrophy of the muscularis (cirrhosis ventriculi). Reduction in size of the organ occurs, often coupled with hyperplastic stenosis of the pylorus. The hypertrophic types of late gastritis are, in my experience, less common than the atrophic form, in which the organ remains normal in size or is somewhat dilated.

Atrophic gastritis may either terminate a simple chronic gastritis or begin as such. The stomach has lost its function of secretion (other than mucus), but usually retains sensation and some motility. The condition appears to me to be due to a gastritis originally more definitely confined to the glands, with relatively less early involvement of the submucous and muscular tissues. The mucous surface is smooth and grayish in complete cases. Areas of hypertrophy, hemorrhage, or small ulcerations ("chronic catarrhal ulcers") may be observed.

There is marked destruction of the gland cells, which are in process of mucoid and fatty degeneration, with final detachment from the basement membrane and disappearance, leaving empty spaces. In advanced cases the gland tubules are lost, irregular, cyst-like formations alone remaining.

Different portions of the same

stomach may show all the pathological changes above described.

SYMPTOMS.—The initial symptoms of chronic gastritis are not well marked, and the condition is usually ignored at first. Later, there is a sensation of pressure in the gastric region after meals, with general oppression. Dizziness, cardiac palpitation, and shortness of breath (asthma dyspepticum) may be experienced. These may be relieved by belching, though local distress tends to persist through gastric digestion. Sometimes the distress and pain continue when the organ is empty, with slight tenderness on pressure over the stomach.

The tongue is coated, and a bad taste in the mouth is experienced, especially after meals or in the morning. The tongue may be red on the tip and margin, with a triangular coating on the dorsum, or may be soft, pale and flabby throughout, showing serrations from the teeth, and with a thin, furry coating. The breath may be obnoxious, especially when the teeth are carious. Faucial and oral catarrh is common, the latter rendering the breath more offensive and foods tasteless. Among other conditions observed are pharyngitis, postnasal catarrh, and stomatitis. Secondary throat involvement results in the so-called "stomach cough."

The appetite is fitful in most cases. More or less anorexia is usually but not always present. Freak selection of foods is common. Piquant, salty, or acid foods may be sought. Satiety from just a few mouthfuls of food or drink is a common symptom. Thirst, however, may be increased; also the salivary and pharyngeal secretions.

In severe gastritis especially, nausea is an early and frequent symp-

tom. It usually comes on after the taking of food, and is relieved by vomiting. Burning may be experienced under the sternum (pyrosis), due to increased hydrochloric or organic acids, together with eructations of sour gas or fluid. Distinct flatulency suggests gastric atony or co-existing marked neurotic disturbance. Vomiting of the entire stomach contents, except in atrophic gastritis, is rarely observed. Regurgitation of smaller amounts is often met with before or after breakfast. In alcoholic cases, retching and ejection of mucus, bile, and saliva are common morning symptoms. Enteritis or a functional hepatic disturbance may be induced.

Early cases seem well nourished. Later, nutrition and health inevitably suffer, even if, as is frequently not the case, sufficient food is being taken. In the atrophic cases a moderate degree of progressive anemia results.

Constipation from atony is usual, and in advanced cases is obstinate. Diarrhea may, however, occur, particularly in heavy drinkers of beer or ale, or those having much intestinal fermentation and putrefaction. Alternate constipation and secondary diarrhea are occasionally met with.

The urine is usually rich in urates and phosphates, indican is commonly present, and albumin, casts, and cells may be found in long-standing cases.

Gastric analyses are necessary to determine the type of gastritis present, the precise treatment to be instituted, the prognosis and the results obtained from treatment. Much definite information is derived. For the methods of examining the gastric contents and the findings to be ex-

pected in chronic gastritis, the reader is referred to the Index-Supplement volume.

COMPLICATIONS.—The commonest complication is chronic duodenitis and diminished pancreatic secretion. Attacks of catarrhal jaundice from occlusion of the common bile-duct or extension higher up in the biliary passages may then occur.

Anemia and debility are often present, later inanition and emaciation. An intense general neurotic condition usually accompanies the atrophic cases, and at times chronic nephritis.

DIAGNOSIS.—This is reached from the symptoms and the chronic course of the disease. The primary and secondary forms usually are easily differentiated by the absence or presence of well-marked causative disease in other organs; yet, when heart, lung, or kidney disease exists, it should not be overlooked that a secondary gastritis may be engrafted on a primary. In atrophic cases the poor general health, nervous disturbance, anemia, and nephritis are of diagnostic importance.

Among gastric disorders, the clinical pictures of ulcer, carcinoma, and the neuroses should be kept in mind, always remembering that chronic gastritis may ensue from any of them, or, on the other hand, precede without being their cause. When ulcer or cancer is strongly suspected, the diagnosis of the more serious condition should always be made.

Gastric Neuroses.—Frequent test-meals will usually differentiate the true neuroses from gastritis. The presence of much mucus, gastric epithelial and gland cells, leucocytes, and low states of hydrochloric acid and pro-enzyme secretion suggest

chronic gastritis. In the distinction from depressive neuroses more reliance should be placed on free organic elements and quantities of mucus than on low secretory functions.

Gastric Ulcer.—In ulcer the pain is more acute and sharply localized, and is increased on taking foods (particularly the coarser varieties). Hemorrhage and vomitus containing much hydrochloric acid are not seen in chronic gastritis. The test-meal usually shows excess of secretions and hypermotility. In chronic ulcer there is more difficulty; secretion may be low, including even mucus. A history of acute ulcer and the greater diffusion, intensity and frequency of the pains are important. The X-rays and fecal examinations may also help.

Gastric Cancer.—Differentiation, though difficult, may be possible from a series of test-meals, and X-ray and fecal examinations. When a tumor is palpable, the gastric contents are characteristic, and the general and other local symptoms of cancer exist, differentiation is easy. Hypertrophic gastritis, with presence of a tumor, occasions much difficulty. The slow onset and the small, smooth, round, movable tumor, always of about the same size, would suggest a benign condition. Bleeding is rare, and there is absence of collective vomiting, the organ being shrunken. As surgical treatment is indicated in hypertrophic gastritis with pyloric stenosis as well as in early cancer, this distinction is unimportant.

Amyloid degeneration of the stomach is always secondary to long-standing suppurations, or, more rarely, leukemia, lead-poisoning, and gout, and may manifest itself as a chronic gastritis, with complete sup-

pression of secretions. This, with the history of other disease, and if amyloid disease is known to exist in the liver, spleen, or kidneys, warrants an assumption of gastric amyloid.

PROGNOSIS.—The average case of chronic gastritis is curable. In the more advanced cases, the progress of the disease can be stayed and the subjective symptoms relieved. Completely atrophic cases, however, are absolutely incurable, though benefit may accrue from careful medical attention. The weaker the gastric secretory functions, the more serious the case; the amount of mucus present is of less prognostic significance. Patients who, after treatment, again become indifferent to matters of proper eating and drinking, are very liable to relapses. The secondary cases improve if the causative disease can be benefited.

TREATMENT.—Prophylaxis involves correction of hasty eating and overeating, excessive use of iced drinks, abuse of alcohol and tobacco (particularly chewing), and bad condition, insufficient number, and faulty alignment of the teeth.

Report of 72 cases of soldier's gastritis with hyperchlorhydria (among 135 instances of dyspepsia in soldiers), due to repeated functional hyperstimulation. Recuperation is favored by a **non-irritating diet**, milk, potatoes, and sugar. Sugar solutions soothe and supply calories. Reduction of gastric secretion is favored by the **highly sweetened diet**. Emptying the stomach and rinsing it with weak solutions of **sodium bicarbonate** is effectual; likewise the ingestion of an **alkaline solution**, with **phosphates, sulphates, and sodium citrate**, half an hour before meals. A suspension of **bismuth subcarbonate**, taken fasting, is of service. Loeper and Verpy (Ann. de méd., Mar.-Apr., 1918).

Lavage of the stomach, coupled with dietetic treatment, forms a valuable therapeutic combination. It benefits by removal of free and adhering mucus, as well as of irritating, stagnant food, and by stimulation of glandular activity. It also prevents intestinal involvement. Removal of mucus is facilitated by allowing the water to run in under some pressure,—a beneficial procedure when atony is not present. The Leube-Rosenthal method is best. In an empty stomach the gastric spray douche may be used with advantage. When primary atony exists, hand siphonage is safer, introducing only small amounts of fluid at a time. When the residual lavage water is from 500 to 1000 c.c. (1 to 2 pints) marked gastric atony or relaxation of the pyloric sphincter is indicated (permitting the escape of the water into the intestines). In the first condition, the water stretches the stomach and is injurious; in the second, the sudden influx may be beneficial for a short time, but in the end injures the intestines.

When residual water is due to gastric atony, preliminary intragastric faradism will so strengthen the organ that lavage without excess of residual water becomes possible.

Lavage should be practised in the morning, before food has been taken. Rarely, when mucous secretion is high, a second late evening washing may be essential. In mild cases, or when benefit from lavage is established, every other or every third day is sufficient. Brief gastric rest is desirable after lavage, which may be done an hour or two before the evening meal, or at 9 or 10 p.m. After such a lavage a **bismuth salt**, **cerium**

oxalate, or the insoluble and bland **magnesia** compounds may be given.

For the removal of adherent mucus in lavage a solution of 3 tablespoonfuls of **sodium bicarbonate** or 2 ounces (60 Gm.) of **lime-water** in 2000 c.c. (2 quarts) of warm water may be advantageously used, followed, for its astringent and stimulating effect when much mucus is being secreted, by a 1:1000 solution of **silver nitrate**. To avoid argyrisms, the stomach should be empty after using the latter, and the measure should not be kept up for more than a dozen or so washings. As the mucus appears to lessen, one may use with the alkaline water, or alone, a weak solution of **tincture of hydrastis** (30 to 2000), or of the fluidextract of **hydrastis** (4 or 8 to 2000). To stimulate acid secretion late in the treatment a 12 to 2000 **hydrochloric acid** solution, always freshly made, should be used. Employment of 2000 c.c. (2 quarts) quantities is always advisable, as most cases cannot be washed clean with less. Addition of antiseptics, such as salicylic acid, is unnecessary. When atrophy of the glandularis is complete, no direct benefit ever accrues from lavage.

The **diet** is to be based on the gastric chemical functions, and be free of irritating foods. Until the symptoms abate somewhat a bland, fluid or semisolid diet should be given, consisting, *e.g.*, of milk, kumyss, matzoön, rice, farina, sago, soft eggs, thin soups, mashed potatoes or soft vegetables in purée or cream, spinach, scraped or finely chopped meats, not very fresh bread, toast, butter and cocoa, etc. In a week or two more solid articles should be added. Meats, rough vegetables, and fiber-bearing

cereals, such as oats, should be resumed with caution, and severely limited in amount. Stimulants, highly seasoned food, pork, new veal, corned or smoked meats, lobster, salads, pickles, cabbage, cucumbers, too hot or too cold drinks, and strong tea should not be used. Coffee, except at breakfast, should be interdicted. In normal or increased acidity the protein-bearing foods may be allowed, but if acidity is low, only fish, eggs, and milk should be used, carbohydrates and cereals being increased both to spare proteins and because of their better digestion. In severe cases, only fluid or finely subdivided foods should be allowed. In constipated cases, the soft green vegetables, fresh fruits, honey and buttermilk, etc., are of service.

If gastric atony exists, four or five small meals a day are best. If not, the usual three meals should be taken. The teeth should be looked after and insistence placed upon thorough chewing and complete insalivation. Disturbing thoughts at the table should be avoided, and for this purpose congenial company is helpful. Habitually overfed patients should stop eating when satiety occurs, or should take a fair amount on their plate before beginning, and stop when this is consumed. Alcoholic drinks and bitters in any form had best be forbidden. When the general health fails, more food should be allowed.

In slight and moderate cases three fair-sized and about equal meals a day should be taken at regular intervals, not too hurriedly, and avoiding mixtures of many foods. To be interdicted are: Foods having pits, seeds or skins; nuts in any form;

anything highly spiced; soups and coffee; oatmeal, tough meats and poultry; rough vegetables, such as cabbage, cauliflower, sprouts, etc.; stews, hashes, and made-up dishes, and foods and drinks that are too hot or too cold. To be taken are: Consommé, bouillon (very small amounts); eggs in any form (two at a time may be eaten twice a day); fish, fresh, and always boiled or baked; beef, lamb, mutton, chicken, or game, in moderate amounts, only once a day or in small amounts twice a day. Meat at one meal and fish at another is a good practice. Meats must be roasted or broiled (chopped raw beef may be eaten with a little salt), always finely divided, cutting the fibers crosswise, and well masticated. Breads, rolls, and plain cake, when not too fresh, are always allowable, and also plain fresh butter in large amount. The best vegetables are peas, beans, mashed potatoes, or baked sweet potatoes. Any of the salads can be eaten with a little vinegar, salt to taste, and olive oil of good quality. Desserts made of the cereals, butter, milk, or cream can be used, but no fruits or berries, pastries, or pies. The best beverage is plain cold water, taken after meals.

A "must not take" diet list serves best after the course of treatment. *e.g.*, foods to be avoided are: One- or two- minute cooked breakfast foods; the rough vegetables—cabbage, sprouts, cauliflower, artichokes, asparagus, beets, celery, corn, cucumbers, kohlrabi, onions, and tomatoes; foods which contain pits, seeds, skins, or nuts; canned and smoked beef or fish; lobster, crabs, shrimps; cheese of any kind, excepting Philadelphia or Neufchâtel; excess of pastries,

especially those cooked in melted fat, such as doughnuts, fritters, etc.; very sweet foods, such as jams, etc.; fruit, cherries, cranberries, figs, grapes, muskmelons; much coffee, strong tea, alcoholic and malt beverages.

Mineral waters are of much value to stimulate glandular activity or neutralize acid. For the former purpose, saline and carbonated waters are of most service, *e.g.*, **Kissingen (Rakoczy)**, **Kochbrunnen**, **Homburg**, **Fächingen**, **Soden**, or **Saratoga (Congress)**. When the acid content is high, alkaline waters are useful, *e.g.*, **Vichy Célestins**, **Wiesbaden (Kochbrunnen)**, **Victoria-Brunnen**, **St. Gallnier**, and **Saratoga (Hawthorn)**. In anemia and atony: **Levico (mild)**, **Mitterbad**, **Orezza**, **Schwalbacher**, or **Stahlbrunnen** may be used. In constipation: **Carlsbad**, **Villacabras**, **Pluto**, or **Mt. Clemens Bitter Water**,—though it is better to move the bowels by dietetic and hygienic means, or by small **enemata of olive oil** instilled each night or **saline enemata** during the day. The saline waters should be drunk before and the alkaline and ferruginous during or after the meal. The aperient waters should be taken before breakfast. Nervous or debilitated patients should not receive them.

A morning **cold sponge bath** is of much service in depressed and phlegmatic cases. Plain water at about 60° F. may be used, though the addition of sea- or table- salt, 1 pound to 10 gallons of water, increases the tonic action. Patients sensitive to cold react more quickly and are more exhilarated by the salt baths, which may therefore be used in conditions of low general vitality. Sprays at below 60° F., with patient stand-

ing in a few inches of warm water, somewhat mitigate the shock. A cold rub with water and a thick towel is to be preferred in the case of very sensitive and nervous persons. **Warm baths** of ten or fifteen minutes' duration may be used in insomnia and agitated states. The **spinal hot sponge bath**, lasting fifteen to twenty minutes, is valuable to induce sleep.

Outdoor **exercise** is of much value, *e.g.*, walking in outlying districts of the city, horseback riding, and rowing. In the home, light dumb-bells or wall exercises may be availed of, or the patient may go through the United States military setting-up exercises for ten minutes each morning and evening. One must insist on these exercises, or patients will soon become very indifferent to them. To obviate this, a daily visit to a well-equipped gymnasium, where companionship during exercise is readily obtainable, is of service. When there is visceral prolapse, abdominal exercises are of value; likewise, sports such as tennis. If atony is marked, a **belt** or **corset** may afford relief.

Sthenic forms of chronic gastritis may require special care of the nervous system. The patient should secure ten or more hours' sleep daily. Where weight, strength, and vitality have become reduced, a "food and rest cure" may be necessary.

Electric treatment comes next in importance to lavage and dietetics. The faradic current, with rather slow interruptions, is most beneficial, often ameliorating the subjective symptoms and gastric motor tone. The galvanic current may be used in acid gastritis without atony. The intra-gastric method is much preferable to the percutaneous. The course of

treatment should last two or three months,—at the start, treatments every other day, then every third, every fourth day, etc., until relief is permanent. In nervous cases a marked psychic and general stimulating effect is often produced by the faradic current. In these cases the spinal and neck regions should be treated with the external electrode. In cases with relaxed abdominal walls, and when atonic or atrophic constipation exists, the general abdomen should be treated.

Under proper dieting, lavage, etc., there need be little resort to drug treatment. In some instances, however, **hydrochloric acid** may be indicated to meet the secretory shortage and stimulate the glands. I doubt, however, the necessity of giving it generally in 40- or 60- drop doses. Give 10 to 20 drops of the dilute acid in a glassful of water, one-fourth of the amount being taken at half-hour intervals after the meal. Addition of pepsin is valueless. Its administration along with predigested foods should be discouraged.

Bismuth salts are direct mechanical sedatives to the irritated mucosa. The **subnitrate** is best for ordinary cases, but the **subcarbonate** has the advantage of alkalinity for acid gastritis. Doses of 15 to 30 grains (1 to 2 Gm.) should be used, and the subnitrate should always be taken before meals or when the stomach is empty. The taking of one 45-grain (3 Gm.) dose of bismuth subnitrate before breakfast or at bedtime is an excellent practice.

When constipation is marked or follows the use of bismuth, the latter should not be continued except in some instances as follows:—

R Magnesi oxidi ʒiiss (10 Gm.).
Bismuthi subnitratis.. ʒv (20 Gm.).
Aquæ destillatæ ʒvj (180 c. c.).

M. Sig.: Take 1 tablespoonful a half-hour before meals. Label "Shake."

Or, in gastritis acida:—

R Magnesi oxidi ʒiiss (10 Gm.).
Bismuthi subnitratis.. ʒv (20 Gm.).
Mistura rhei et sodæ. ʒvj (180 c. c.).

M. Sig.: Take 1 tablespoonful one-half or one hour after meals. Label "Shake."

When mucous secretion is copious, I first **wash out** the **stomach** with 2000 c.c. (2 quarts) of an alkaline solution, then follow this immediately with 1000 c.c. (1 quart) of a 1:1000 **silver nitrate solution**. By the use of an irrigating stand holding a 2000-c.c. (2 quarts) and a 1000-c.c. (1 quart) glass irrigator, side by side, with short tubes from each glass jar, this is rapidly done. When the alkaline solution has been run through the stomach, the tube from that jar is slipped off the Y-tube, and that from the silver solution put on instead.

In atrophic gastritis, when acids are not well borne, **foods** suitable for intestinal digestion should be advised and the stomach kept alkaline for this purpose. **Sodium bicarbonate**, **magnesium oxide**, and dried **sodium carbonate** may thus be used with the meals, which should be frequent, small, and fully subdivided. **Pancreatin**, with the alkalies, is of value.

The treatment of special symptoms in chronic gastritis is as follows: For anorexia: **Lavage**, **nux vomica**, **condurango**, **gentian**, and **orexin**. For nausea and vomiting: **Careful diet** and **lavage**, **hot applications** to the **abdomen**, **cerium oxalate**, and **chloral hydrate**, 2½ grains (0.15 Gm.), in **chloroform-water**, 1 fluidram (4 Gm.). For pain: **Liquid diet** or **brief ab-**

stinence from food, lavage, hot applications, galvanism, and bromides. For deficient gastric juice: **Lavage** and diet, **dilute hydrochloric acid**, **nux vomica**, **gentian**, and **general tonic measures**. For motor insufficiency: **Electricity**, **hydrotherapy**, **frequent small meals**, **nux vomica** or **strychnine** in rather large doses. For psychic depression: **Electricity**, **cold sponge** and **surf baths**, **general tonics**, **high caloric feeding**, and a **sojourn in the country**, or in a well-ordained **sanitarium** for digestive diseases. For constipation: **Proper diet**, **electricity**, **exercise**, **going to stool regularly** whether the bowels move or not, **compound licorice powder**, **cascara sagrada**, or **rhubarb**, **rectal enemas** of **salt water**, and **avoidance of strong purgative pills** or tablets, except occasionally for cleansing the bowels.

Surgical Treatment.—In well-established hypertrophic stenosis, causing retention, and with the organ much contracted, **pylorectomy** is in order. If a **pyloroplastic operation** (particularly the Finney) can be performed, it serves the purpose better, but as the organ may be markedly contracted to the left and away from the duodenum, a **pylorectomy** may be the only operation possible. Unfortunately, the gastric tissues are in such poor condition for union that the mortality is high; these patients, moreover, are mostly alcoholic and cannot stand the operative shock. Ordinary gastroenterostomy should not be performed, these stomachs continuing to thicken after the operation, and thereby closing the communication, and also because the offending pylorus is not removed.

GASTRIC AND DUODENAL ULCER.—It is now recognized that

ulcers of the stomach and duodenum should be described together, since the first part of the duodenum, in which 90 per cent. of the duodenal ulcers are found, is embryologically and physiologically identical with the stomach. The combined statistics of 59,450 autopsies of various series showed evidences of healed or unhealed ulcer in 4.4 per cent. of instances. The disease is said to occur more frequently in women than in men; some even claim a ratio of 3 to 1, but in my experience there is no difference between the sexes.

ETIOLOGY.—Some believe that a local devitalization of the mucosa may take place, its specific immunity being lost, and autoingestion cause the production of an ulcer. Trauma has long been believed to be a cause, and there is no doubt that a break in the mucous membrane can take place from a violent blow upon the upper abdomen. Probably an occasional case of gastritis results in such local conditions present as might cause an ulcer. A high content of gastric juice, combined with a low secretion of protective mucus, can apparently at times cause an ulcer. Gastric exfoliation is much more common than is ordinarily supposed, and in cases of high HCl secretion more exfoliation takes place than normal. Arteriosclerosis is common in ulcers of those beyond middle age, and this, with localized bacterial infection, may lead to thrombosis, loss of local vitality, and autodigestion. Experiments seemingly prove that certain bacteria injected into the free circulation produce ulcer.

PATHOLOGY.—The characteristic ulcer is funnel-shaped or crater-like, quite deep, circular or oval,

PHYSICAL EXAMINATION OF ULCEER

irregular, linear or terraced, and superficial in form. The acute ulcer is usually soft with rounded edges; the chronic and irritated, rigid, particularly at the edges, from round-cell infiltration and hemorrhages and connective- or scar- tissue. The base is often smooth and covered with greenish or brownish tough mucus, though small superficial ulcers often show no such deposit. The simple ulcers vary in size from 1 to 4 centimeters.

I recognize twelve different special forms of ulcers.

SYMPTOMS.—In simple ulcer these are often characteristic enough to make a diagnosis possible. In atypical cases, *i.e.*, those in which pain, hematemesis, vomiting, excessive secretion, gastralgia, etc., are masked or lacking, diagnosis requires most careful study. Lastly, in a minority of cases, diagnosis is impossible by medical means.

Pain in gastric ulcer is a prominent symptom. It may be burning, boring, cutting, tearing, or a constant dull ache. Its character changes from taking food or drink and even with posture. Its paroxysmal occurrence is, however, constant in the history of a typical acute ulcer case. It is due to irritation of the ulcer and to consequent (or normal) contractions. It occurs either immediately after the taking of food or after its saturation with hydrochloric acid. Often in pyloric or duodenal ulcer, it begins two to four hours after food. It is usually localized in a small area in the pit of the stomach near the median line. In duodenal ulcer especially it may be referred to the right side.

During the paroxysm the pain extends through the body and may

even radiate up the back and chest. Vomiting and retching, gastric distention, pylorospasm, and the taking of coarse foods or irritating drinks, increase the pain, and usually some degree of pressure on the abdomen affords relief. If there be hyperacidity, taking milk or eggs often relieves the gastralgia.

Two spots of tenderness usually exist in simple ulcer. The *epigastric* is found in about 80 per cent. of cases, both in about 30 per cent., and the *dorsal* alone in rare instances. The dorsal pain is elicited, on deep pressure, at the level of the tenth to the twelfth dorsal vertebræ, alongside the vertebræ, in a lateral expansion about 2 or 3 centimeters square.

Vomiting occurs in about 70 per cent. of cases, usually with gastric pain or distress. It may come on whenever foods or drinks are taken, or only at intervals of several days or more. It is usually intensified by the ingestion of much food, though perhaps relieved by small amounts. When pyloric stenosis, organic or spasmodic, exists, the contents may display evidences of retention.

Blood is present in the vomitus in probably one-third of all cases, and when in visible amounts is strongly significant of ulcer. It is usually arterial, and may be copious or more of an oozing. After a frank hemorrhage the feces are reddish, dark brown, or black; if the quantity of blood be moderate or small, blood tests are required to detect it.

Free acid and free secretion are usually found. It is necessary to examine, a test-meal, and not vomitus. Careful use of a stomach-tube is usually permissible. Sometimes gastric secretion is normal, or perhaps even

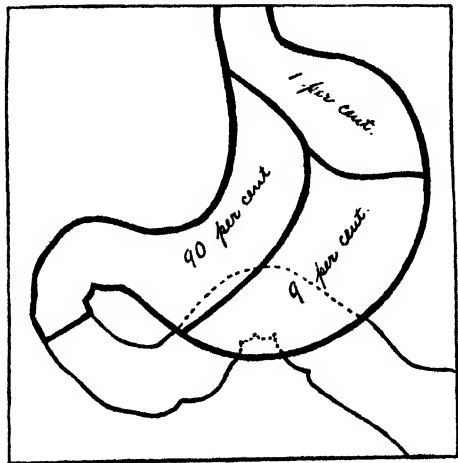
subnormal. Mucus in flakes or masses is not unusual.

Among the general symptoms may be noted weakness and emaciation, anemia, regurgitation of acid and gas, certain nervous phenomena, thirst, constipation, nausea, and faintness.

Perforation occurs, early or late, in about 5 per cent. of all ulcer cases, and may be the first symptom of ulcer noted. Two types are recognized: those associated with acute ulcer and those occurring after more or less cicatrization has taken place. Usually there are no premonitory signs, though in a few cases localized pain precedes. Perforation of the unprotected anterior gastric surface in the pyloric region causes extravasation into the free perineal cavity. Perforations of the lesser curvature open into the lesser peritoneal cavity and those of the posterior wall (duodenum included) in the cellular tissue behind, perhaps to the ascending colon or kidney. Less common ruptures are through the diaphragm and pericardium, causing such conditions as pneumopericarditis, pneumothorax, pyopneumothorax, or mediastinal involvement with external emphysema. An encapsulated subphrenic abscess is sometimes produced. Among the possible results of perforation are abscess of the liver, chronic hepatitis, pyelophlebitis, septic cholecystitis or gall-duct obstruction, left-sided cellulitis, perisplenitis, left renal involvement, and intestinal fistulas. In the latter instance there may be severe diarrhea, bloody or purulent feces, and fecal vomiting. When the renal pelvis is entered there is usually pyuria. Rarely an external fistula is produced. In favorable cases the infection becomes localized. A chronic

course may ensue, and later an exit be formed in the renal pelvis, intestinal canal, vagina, or abdominal wall.

Perforation into the free peritoneal cavity is by far the most frequent occurrence. If in the anterior gastric wall, perforation sets up a general peritonitis more commonly and rapidly than do ulcers of the duodenum and those elsewhere in the stomach. The gastric contents are more infective than the duodenal;



Showing the location of gastric ulcers as noted in cases of perforation.

the duodenum, moreover, is tightly moored in its upper part, small, deeply set, and more protected by adjacent structures than the stomach.

Moynihan has classified cases of perforation into acute, subacute and chronic. In acute cases the onset is sudden, the peritoneum freely entered, and the symptoms severe and general from the beginning.

In the subacute cases the onset is less sudden or severe, the opening small in size, the stomach empty; adhesions have formed, or the omentum or transverse colon and meso-

colon prevent extension. Localized peritonitis or abscess formation has previously been present. The symptoms are: increased pain, rather sharply localized; moderate fever, and a suggestive white blood-cell count.

In the chronic cases, protective adhesions have first formed, and the symptoms are ephemeral or those of abscess. Later, general peritonitis may develop. Extensive adhesions are common, especially with the liver, pancreas, colon, small intestine, and omentum.

In a few cases of ulcer, perforation may occur very late, due to autodigestion of the center of an old scar, gradual attrition, marginal erosions, or malignant degeneration.

Perforation usually causes sudden agonizing pain, with extreme tenderness in the upper abdomen. Soon the pain spreads across the abdomen. Deep breathing causes it, suggesting pleurisy. At first the abdomen is flat, tense, and fixed. Later it distends, though still rigid; finally, when peritonitis exists, a softening is noted. Liver dullness is absent in about one-fourth of the cases, diminished in one-half, and not affected in the others.

Stomach percussion is neither possible nor advisable. Collapse and prostration soon supervene. The pulse is usually accelerated, but at first may be down to 30 or, for a time, normal. The temperature soon rises, as a rule not above 102° F., or becomes subnormal. The slower the onset, the higher it is. The face is pale and anxious.

The great majority of neglected cases finally display marked distention, obliteration of liver dullness, vomiting, singultus, cold skin, facies Hippocratica, a small running pulse,

unconsciousness, and Cheyne-Stokes respiration, followed by death.

It is in subacute perforation cases that the internist is very liable to delay transferring the case to a surgeon until too late. The early symptoms are mistaken for those of perigastritis or lymphangitis from the ulcer, or are vague or absent until local or general peritonitis has ensued. Here the internist shoulders a great responsibility. At the least suspicion, a blood-count should at once be made, and repeated every few hours. If the leucocytosis steadily increases, the neutrophiles showing a relative increase and the eosinophiles perhaps diminishing or disappearing, immediate surgical intervention should be insisted upon.

Sudden abdominal pain, usually after a strain, as in vomiting, defecation, bodily exercise after a heavy meal, trauma, etc., followed by the symptoms already enumerated, should suggest the possibility of perforation.

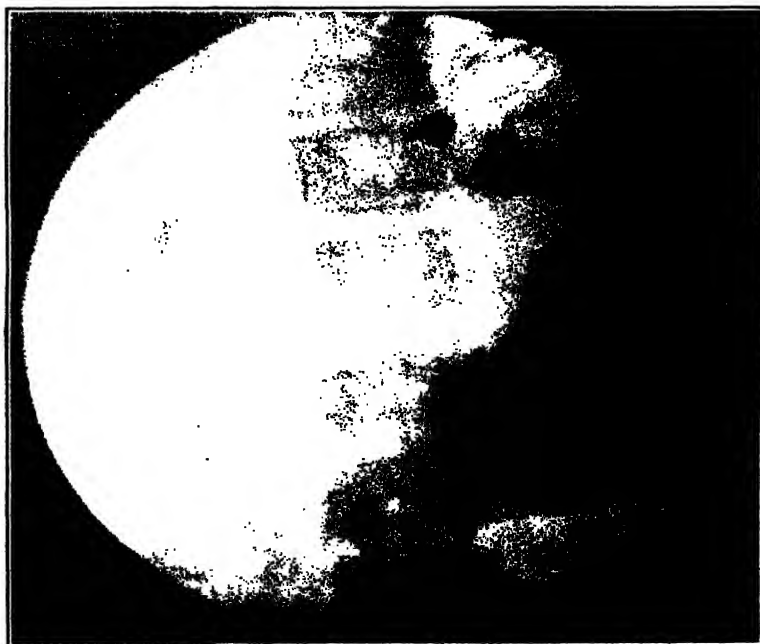
The few cases of pseudoperforation reported do not justify hesitancy as to surgical intervention.

Whenever, in cases of gastric ulcer, the respiration rate rises perceptibly, the chest should be examined for fluid or gas in the pleura. Chills and a septic temperature should draw attention to such conditions as hepatic, subphrenic, or mediastinal abscess, or infection in the lung, pleura, or general system.

Special Features of Duodenal Ulcer.—Experience in the operating room shows that duodenal ulcer is about twice as frequent as gastric. Most duodenal ulcers occur in the first portion of the duodenum, within three-fourths inch of the pyloric



Gastric Ulcer. Arrow pointing to ulcer of posterior wall near pylorus.
Case proven by operation. X-ray by Author.



Gastric Ulcer Directly at Pylorus, Causing Deformity of Pylorus,
Retention and Globulation of Stomach. Case proven by operation.
X-ray by Author.

sphincter, and are chronic in type. From a clinical standpoint, what has been stated regarding gastric ulcer is also true of duodenal ulcer. Clinically and surgically their differentiation is not of much import. The term "pyloric ulcer" seems best.

In duodenal ulcer the pain is usually not so acute as in gastric ulcer, more burning and boring in character, and commonly median or slightly to the right. But it may be excruciating, and may even be felt near the right costal margin, though rarely down as far as the gall-bladder. Remissions of pain, often without apparent reason, are frequent. The pains occur usually from one to three hours after ingestion of food, and are relieved temporarily by the taking of food or alkalies. Characteristic, in my experience, is pain beginning about 2 o'clock in the afternoon, becoming worse until almost midnight, then disappearing. Another type of pain occurs between 2 and 4 o'clock in the morning. Tenderness may be confined to the right side along the course of the duodenum, with perhaps a referred pain in the back. Vomiting is rare. The vomitus seldom contains blood. Copious hemorrhage into the stomach with ejection may occur, or the same take place into the bowel, with melena. An ulcer case without blood in the test-meal analysis, but blood in the feces, is likely to be duodenal. Incorporated blood in the stool is always suspicious of ulcer high in the intestine. Melena, when present, is important. Constant bleeding generally causes pallor, reactionary fever, weakness, and loss of weight. About one-half of all gastric and duodenal ulcer cases at some time show blood in the feces.

Jaundice has often been observed from obstruction of the common bile-duct or coincidence of ulcer with cholelithiasis. If pain is persistent, often not enough food is taken to maintain weight. This is important in differentiating between ulcer and gall-bladder disease; in the latter the patients eat well and maintain good nutrition.

Duodenal ulcers are liable to perforation mostly in the anterior wall. Those in the second part, anteriorly, lead directly into the peritoneal cavity, while those on the posterior surface are extraperitoneal.

DIAGNOSIS.—When the classical symptoms are present, which occurs in about 1 out of 4 cases of ulcer, diagnosis is easy. By close attention and study about 2 of the remaining 3 cases can be diagnosed. Special technique and laboratory tests here offer substantial aid. In the remaining, fourth case diagnosis is impossible unless complications develop.

For X-ray diagnosis an ulcer must be large enough or have caused adhesions sufficient to produce an irregularity of the contour of the stomach or duodenum. When the symptoms are not distinctive, the X-ray should be used.

Einhorn's method consists in swallowing a "duodenal bucket" attached to a long silk thread. The bucket is ingested in the evening and removed in the morning before breakfast. The ulcer causes a brown or dirty black stain on the string, and by measuring the distance from the teeth its site can be approximately determined. I have employed, with good results (see plate opposite next page), a BB split shot, fastened to about 100 centimeters (38 inches) of No. 8

braided silk. The shot is inclosed in a 5-grain capsule, the cord passing through a small hole in one end, and a knot is tied on the string 75 centimeters (28 inches) from the capsule. A number of these are kept on hand, each one wound around a card and placed in an envelope bearing the following instructions:—

"For several hours before beginning this test no medicine should be taken, and for supper no meat is allowed, the meal preferably consisting of milk, eggs, bread and butter. At bedtime you are to swallow the capsule and thread until the knot is at the teeth. The end of the string is then made into a loop and fastened to the nightgown with a safety pin or tied around one ear, so that the knot remains in place—the shot remaining in the stomach all night. On awakening, pull the string slowly and steadily and hang it up to dry, being careful not to allow anything to touch it while wet. When dry place it in a clean envelope and mail it to me or leave it at my office."

A number of my cases have been most easily diagnosed by this string test, some showing none of the cardinal symptoms of ulcer,—particularly the latent cases. The test is not objected to by patients. It may also be used to trace progress under treatment.

The string method is not of value, however, in ulcers of the fundus and greater curvature. For these Einhorn has devised a bag covered with gauze, which is introduced into the stomach in a collapsed condition and then inflated. After a half-hour the bag is allowed to collapse and withdrawn. If ulcers are present, brownish areas are noted in the gauze. The method is only applicable in patients accustomed to the stomach-tube.

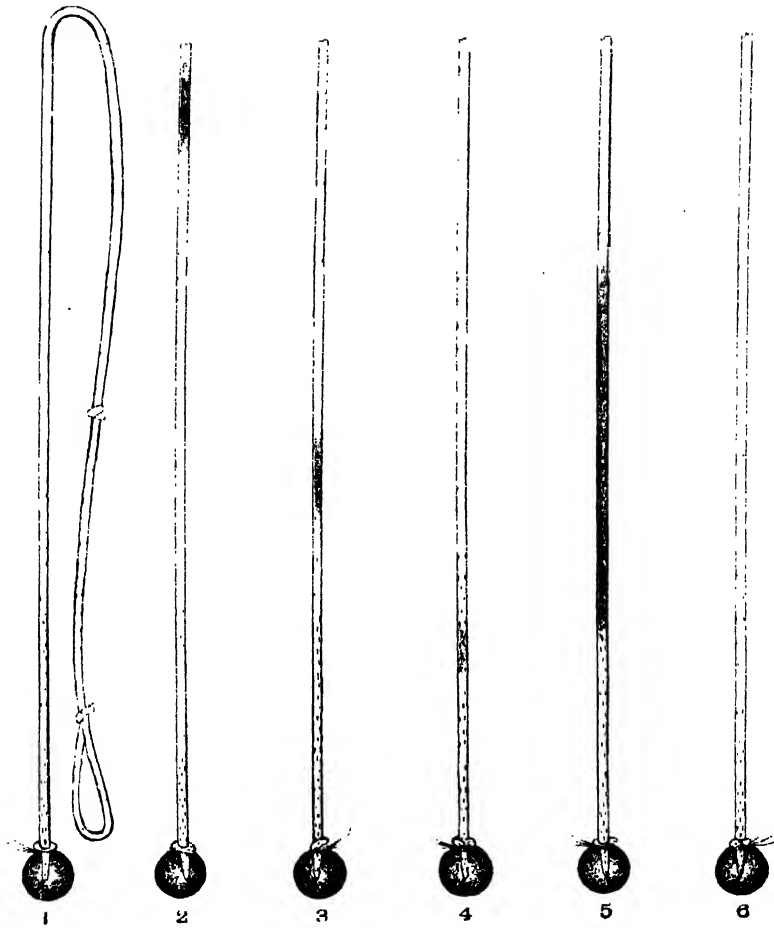
DIFFERENTIAL DIAGNOSIS.

—**Gastralgia.**—Here the pain is independent of food, is usually a burn-

ing, and relieved by pressure or heat, though not by vomiting. There is commonly eructation of odorless and tasteless gas, and perhaps salivation. No blood appears in the test-meal. No fever is present. Hysterical and neurasthenic symptoms are common. There is no definite area of sharp pain, but rather a diffuse tenderness in the epigastrium. Epigastric pulsation may be noted when prolapse or atony exists. During the attack constipation is the rule, and afterward the passage may be fluid, containing mucus but no blood. The condition soon subsides, possibly without treatment. Some hyperesthesia may persist for some time, generally subsiding under bromides.

Carcinoma.—Here debility and emaciation often precede the other signs. Pain is more constant, less severe, less dependent on food, and often nocturnal. Anorexia is frequent, and the taste insipid, commonly with aversion to meats. The appetite may improve under lavage. Fetid eructations are frequent. Digestion is insufficient, stagnation of foods common, and the chemism in late cases shows absence of hydrochloric acid and the presence of blood, Boas-Oppler bacilli, lactic acid, and pieces of cancer tissue. Vomiting gives less relief than in ulcer, and is often of the "coffee grounds" type. Cachexia is marked, and the skin sallow, brown, dry, or flaccid. The patients are usually aged. A tumor may be palpable. Perforation occurs only after prolonged illness and, when into the colon, lientery may occur. The X-rays are of diagnostic value.

Hyperchlorhydria and Gastrosuc-corrhea.—In these conditions there is absence of distinct pain and tender-



Results of the string test in different conditions. No. 1, Normal; the bile stained lower end usually stains the string for a distance of about 15 cm. (6 inches) from the shot, gradually fading out on the way upward. No. 2, Esophageal ulcer, the blood-stain corresponding to above the cardia. In esophageal carcinoma, because of the stenosis, the shot and string may remain in the gullet and a considerable extent of the lower end of the string be blood stained; in this instance the lower end of the string would not be bile-stained. No. 3, Gastric ulcer, the blood-stain corresponding to the lesser curvature of the stomach near the pylorus, but at the upper end of the bile-stain. No. 4, Duodenal ulcer; the blood-stain is small in area, and the bile-stain extends beyond it, showing that the bleeding is beyond the pylorus in location. No. 5, Gastric carcinoma, showing that considerable hemorrhage was taking place, staining the string throughout the stomach. Some of the cases show a blood-stain small in extent, and, if the pylorus permits the passing of the shot, a bile-stained end; the string then would resemble that of gastric ulcer. Other cases show a general blackish-green staining of the string, which displays the presence of blood by the chemical tests. No. 6, Gastropotosia, showing that a long, attenuated stomach took up the distance of string, permitting but a small extent of it to get into the duodenum. (*Bassler.*)

ness. Vomiting is rare and usually follows an error of diet. Distress is worst one to three hours after meals (hyperchlorhydria) or in the early morning (gastrosuccorhea), though actual pain is rare. High hydrochloric acid content, low conversion of starches, and an abundant return are the main diagnostic features. There is belching of acid gas or regurgitation of acid fluid, with postprandial pyrosis. These conditions usually respond to proper treatment; if not, latent ulcer, underlying gastritis, cholelithiasis, chronic appendicitis, or a nervous disorder should be suspected.

Hemorrhagic and Other Forms of Gastritis.—Differentiation is difficult and usually impossible. Its importance is so slight that surgery is especially prone to failure in dealing with excessive hemorrhage from the stomach. Thus it is advisable to continue medical treatment. If the case entirely recovers and subsequent examinations are negative, one should consider the possibility of hemorrhagic gastritis as having existed.

In ruptured varix of the stomach, in which bleeding may be difficult to control, the classical symptoms of acute ulcer are usually lacking.

In ordinary acute gastritis, and sometimes in the hemorrhagic form, there is the history of the cause, followed by acute vomiting of the food and possibly later of mucus and bile. The pain is less acute and more diffuse. In chronic gastritis the cause and the analyses are important. When blood or eroded pieces of the glandularis are found the diagnosis of secondary ulcer should be made.

Pylorospasm is a misleading condition when not accompanying gas-

tric or duodenal ulcer. It may occur in gastric or general neuroses, cholecystitis, gall-stones, appendicitis, and tuberculosis of the abdominal viscera. The diagnosis of uncomplicated pylorospasm is usually made by exclusion of all organic disease and from attacks of pyloric pain with stagnation. The attack usually occurs at the height of digestion. Later gastric dilatation ensues, and food is vomited late after ingestion. The contracted pylorus may be felt as a small, round, tender mass, disappearing in the intervals between seizures. Chronic gastrosuccorhea or telany may exist. Blood is absent. Lactic acid may be present, but Boas-Oppler bacilli are rare.

Appendicitis.—Mistaken diagnoses of perforating acute gastric or duodenal ulcer for appendicitis, and *vice versa*, are numerous. Appendicitis and erosions and ulcers of the stomach are frequently associated. Payr observed that "in a certain number of cases of appendicitis, usually of moderate severity, there appear, shortly after the first attack, various gastric symptoms closely resembling those of gastric ulcer. There is pain, occurring shortly after the taking of food; hyperacidity; vomiting, frequently bloody in character, and, usually later, phenomena suggestive of pyloric stenosis. These symptoms generally abate after a short time. He ascribes these gastric disturbances to emboli derived from thrombosed veins of the omentum and appendix.

In differentiating severe appendicitis from perforating ulcer the situation of the onset of pain is most important. Rigidity, local tenderness, and swelling, whether below the um-

bilical level or above it, are guiding points. If the abdomen distends, differential diagnosis is neither possible nor important. The abdomen should immediately be explored in both its upper and lower zones through an incision. The differential diagnosis can in every instance be made more surely and safely by the surgeon.

Hyperemesis of Pregnancy.—The history and local examination are here all important. No pain is present, and the characteristic symptoms of ulcer are absent. The same applies to vicarious menstruation, and to conditions in which blood is swallowed and vomited or enters from or through the gullet.

Uremia.—Here the low urinary output and the uranalysis are diagnostic. Headache, sleeplessness, paralysis, amaurosis, convulsions, mania, delirium, coma, increased arterial tension, and dyspnea are significant symptoms. General muscular spasm and fever may be present. Where consciousness persists examination of the abdomen is negative, but late in the case distention without rigidity may be observed. The vomiting may be incessant and, if a uremic ulcer exists, blood may occur in the vomitus or feces. In my experience, the vomitus has usually been gastric juice, especially during fever.

Biliary Conditions.—In gall-stones, when tenderness is elicited only by deep pressure in the biliary triangle, and there is jaundice, with bile in the urine and the characteristic pains, the diagnosis is easy. But when the pains are constant, especially after food, coupled with vomiting which affords relief, and the signs just mentioned are lacking, time and care are usually required. Gall-stone

cases are apt to be ruddy and well-nourished, while those of ulcer often show anemia and poor nutrition. There have usually been long intervals between the paroxysms of pain, with a much better digestion than is seen in ulcer cases. Gastric analyses rarely show blood. Hyperacidity is common. Duodenal or gastric ulcer may coexist with gall-stones. In most of these cases the diagnosis of gall-stones is the easier to make.

If a chill with fever, hepatic enlargement, and a swollen, tender, and palpable gall-bladder are noted, the diagnosis of gall-stones is suggested, and this is confirmed if stones are found in the feces in succeeding days. In hepatic colic pain may occur in the epigastrium, but it quickly radiates to the right costal margin, around to the back, and beneath the right scapula. It is more colicky in character, coming on more suddenly and ceasing more abruptly. The pain and the suffering are more acute, and are usually independent of food. The patient often feels chilly, sweats profusely, is nauseated and vomits, and usually there is a slight rise in temperature, with jaundice following in about 50 per cent. of the cases. The right side of the abdomen is rigid and tender, especially during inspiration. The history of attacks of hepatic colic, the absence of ulcer findings, and the limitation of pain and tenderness to the biliary triangle, particularly when the abdomen is palpated from behind, are the main points in differentiating the chronic gall-bladder conditions.

Renal Colic.—In nephrolithiasis the urine is strongly acid and contains blood, usually enough to give it a smoky tint. Small calculi may be

passed or detected in the pelvis or ureter with the X-rays. The intensity of the pain in the back, radiating downward (usually only one side), and the absence of pain and tenderness anteriorly are significant. Abdominal examination is negative, or the entire abdomen may be board-like during ureteral colic.

Arteriosclerosis.—Chronic abdominal pains may occur in sclerosis of the splanchnic vessels. The symptoms peculiar to ulcer are absent, and the gastric contents commonly achyllic. Palpable vessels are firm and arterial tension persistently high. Much urine may be voided, often of low specific gravity, and with a little albumin, and granular casts. Intestinal putrefaction is common.

Spinal and Other Diseases.—Among other conditions that have been mistaken for gastric ulcer are: *Tubes* with gastric crises, myelitis with pains as a prominent feature, movable kidney, lead colic, enteralgia, herpes zoster, intercostal neuralgia, and diaphragmatic and basal pleurisy. Careful examination will generally clear up doubts.

Post-ulcer conditions that may require differentiation include perigastritis, pyloric obstruction due to cicatrices, hour-glass contraction, and carcinomatous degeneration. All of these conditions are best examined for with the X-rays. Other possible conditions are persistent excess of secretion, irritable stomach, erosions of vessels, and tetany.

Advantages of the fractional test meal described. In gall-bladder disease the secretory response is prompt with high acidity, and the emptying time occurs at or near the high point. In duodenal ulcer there is a prompt gastric response, high acidity, and

delayed emptying time. In gastric ulcer, not affecting the pylorus, there is a weak and delayed response, moderate acidity, and early emptying time. Gastric carcinoma presents two types of curve, the first showing the presence of acid and a delayed emptying time, and the second showing the absence of acid and an early emptying time. Horner (*Jour. Amer. Med. Assoc.*, Dec. 8, 1917).

PROGNOSIS.—Acute ulcers (including erosions) are curable by medical means or recover without especial treatment in at least 95 per cent. of cases. The mortality from all kinds of ulcer variously given as between 10 and 20 per cent. pertains only to the most serious cases. In the complications and sequels in serious cases, on the other hand, the results accruing from medical treatment up to the time of operation are poor, particularly because they comprise the small percentage of the easily diagnosed ulcers that do not recover.

A case which has been diagnosed as ulcer by medical means, and in which a restoration to health has continued for one year, is logically a cured case; yet, in a very small percentage of these cases, surgical measures may at some subsequent time be indicated.

The result of acute ulcer is scar formation. The chronic ulcers, however, usually remain more or less open or become thickened. Malignant degeneration, if it occurs, progresses to a fatal ending, unless operated upon in time. Unless overwhelming, intermittent hemorrhages are acute and likely not to cause death; the continuous forms are chronic and usually require surgical intervention. Ulcers giving distinct symptoms, properly treated, tend toward complete recovery.

ery in at least 75 per cent. of cases; those that do not are always surgical.

The prognosis of acute ulcer depends upon the depth, extent, location, and character of the lesion, and willingness of the patient to follow orders for some months. In the severer cases it is wise to be conservative and always watchful.

PROPHYLAXIS.—Excess of secretion is the most important feature in this connection. The treatment for it should be that outlined in hypersecretion. (See Hyperacidity, given earlier in this article.) In addition, any anemia should be corrected by a full diet and hematinic tonics, and debility by high caloric feeding and extra meals of a liquid albuminous character. Hygienic measures often offer substantial aid.

TREATMENT.—The ulcer patient should be put to bed, and the strictest discipline as to complete rest, dieting, medicinal treatment and hygiene insisted upon. Even in erosions, at least three weeks in bed should be insisted upon, and preferably four. With such discipline, general results are better and the dangers of hemorrhage and perforation are minimized. After this, the transition from **rest in bed** to walking about should extend over two weeks. In a case free of symptoms, a return to the ordinary fare can then be begun.

Diet.—Coarse vegetables and cereals, highly seasoned foods, made-up dishes, hashes, salted and preserved meats and fish, and meat soups should be excluded. Preserved fruits, pickles, fresh berries, or vegetables with seeds, and also nuts, are dangerous. Alcoholic beverages, as well as tea and coffee, should be interdicted. Among the useful foods

are gruels, milk soups and purées, and other foods cooked with milk. The best fluids are water, milk, Vichy, and cocoa. White bread is permissible. Tender beef, lamb, chicken or fowl and fresh fish may be taken once a day, but must be roasted or broiled, finely cut up, and thoroughly masticated. Eggs in any form, with but little salt, may be taken *ad libitum*. Cereals and vegetables should be well-cooked, and potatoes and other tuberous vegetables mashed.

The evening meal should be of fluid, semifluid or finely comminuted foods, with little seasoning, and small in amount. Supplemental fluid albuminous meals should be given between dinner and supper, and before retiring. Very hot or cold foods should be avoided. In the first month or two of mixed diet, rest for one or two hours after meals should be insisted upon, and also the avoidance of all business and irritating topics of conversation. If hyperacidity then persists or recurs, **bismuth subcarbonate**, the **mineral alkalies**, plain **Vichy water**, and the oils or **atropine** should be given. The bowels should be moved only with **Carlsbad salts**, **magnesium hydrate**, or by **enema**. If circumstances permit, a **sojourn in the country** or a course at **Carlsbad**, **Vichy**, or **Ems** should be advised. Beginning two months after the conclusion of active treatment and at regular intervals during the first year, gastric analyses should be made and the feces examined for blood. If acidity increases, or blood appears in the stomach contents or feces, or gastric distress ensues, the case should be more rigidly treated, and perhaps again put to bed for a week or two.

If gall-stones or appendicitis is present, operation should be insisted on.

One patient may do best on early, rather generous feeding as recommended by Lenhartz, and another become distinctly worse until complete gastric rest has been afforded for several days, as practised by von Leube. The results seem to depend upon the gastric and pyloric spasm, the age of the ulcer, the amount of bleeding and vomiting, and the general excitability of the organ. As a rule, it is best to adopt von Leube's method for the first few days, and when the symptoms abate, Lenhartz's method until the end of the fourth week of treatment. Less severe cases occur in which the Lenhartz method should be used from the outset, and likewise more severe cases in which the Leube method is required for a considerable period. The patient's general condition should be taken into account in deciding on treatment. If oral feeding or a fuller fare is long delayed after the use of the nutritive enemas, a distention of the stomach, with sudden increase in acidity, may occur and may precipitate vomiting and prevent healing of the ulcer. On the other hand, the Lenhartz feeding is likely to increase or maintain the excessive acidity of the gastric juice, and though cure of the ulcer is obtained, a high level of gastric secretion remains which, to some extent, favors recurrence.

The dietetic treatment of von Leube and von Ziemssen is based on rest in bed, and feeding by the rectum or with food which will burden the stomach as little as possible. Ewald's modification is described by him as follows: "For the first three days absolutely no food is to be ad-

ministered by mouth, but a nutritive enema is given three times daily; subsequently, besides the enemata, milk or flour and milk soup, in teaspoonful doses, or a bland pigeon or chicken broth. To the milk, on account of its fine floccular-coagulation, some peginin is added. If this diet is well borne, it is added to as herein-after described; otherwise, absolute rectal nutrition is again instituted. If no pain follows the careful administration of milk, one may permit somewhat larger quantities (up to about 180 cubic centimeters), leguminous flour soup, then legumes; later pappy food made of chestnuts, sago, tapioca, Kufek's flour, hygiama, and other preparations, and later small quantities of meat. Among nutritive substances cows' milk takes first place. . . . The patient, however, must drink it very slowly and lukewarm. To prevent flocculent coagulation of the milk and the resulting irritation of the ulcerative surfaces, I now add peginin (labferment), which produces a very fine flocculent coagulation. Besides pigeon or veal soups, the yolk of an egg and beaten-up egg-albumin, pulverized meat, or leguminous soups may perhaps be given. We must limit ourselves to these foods until the severe symptoms have disappeared. In the third week food richer than this, both quantitatively and qualitatively, is permissible, and one should then carefully try food of somewhat greater consistence, such as scraped raw ham, raw or very soft-boiled eggs, scraped venison or breasts of fowl, and rolls or zwieback softened in cocoa; but milk is always preferable, and one should always be ready to return to a simpler diet as

soon as the symptoms, or even pains, appear." The diet of Ewald may be considered as a conservative and rational combination of well-tried methods. Arguing for its use in preference to that advised by Lenhartz, he reports having had but 4.8 per cent. of hemorrhage, whereas, Lenhartz, in 20 cases, had 6.4 per cent.

Lenhartz's dietetic treatment is based on the fact that hyperchlorhydria, chlorosis and anemia frequently develop in the course of ulcer. Even in severe cases he permits from the start concentrated foods rich in albumin. In general, the Lenhartz diet is the best to employ—simply because the average case is not severe enough to call for complete gastric rest.

In the **Lenhartz plan of feeding**,

food is administered in small quantities at one-hour intervals. Slow mastication and slow eating are insisted upon, the patient being fed with teaspoonful amounts, and not allowed to feed himself during the first two weeks of the cure. Three or four weeks' rest in bed is imposed. An ice-bag is applied to the epigastrium to relieve the pain, and bismuth subnitrate given internally for hemorrhage. Milk and beaten-up raw eggs are placed in tumblers surrounded with cracked ice and kept at the bedside. The feeding spoon is also kept iced. The eggs and milk are administered in alternate feedings, granulated sugar being added to the former on the third day. The raw, scraped beef, boiled rice, and zwieback are prepared in the usual manner. The diet routine is as follows:—

DAY.	EGGS.	MILK.	SUGAR.	SCRAPED BEEF.
1.	2 drams per dose. Total, 2 eggs.	4 drams per dose. Total, 6 ozs.		
2.	3 drams per dose. Total, 3 eggs	6 drams per dose. Total, 10 ozs.		
3.	½ oz. per dose. Total, 4 eggs.	1 oz. per dose. Total, 13 ozs.	20 grams added to eggs.	
4.	5 drams per dose. Total, 5 eggs.	1½ ozs. per dose. Total, 1 pint.	Do.	
5.	6 drams per dose. Total, 6 eggs.	14 drams per dose. Total, 19 ozs.	30 grams.	
6.	7 drams per dose. Total, 7 eggs.	2 ozs. per dose. Total, 22 ozs.	40 grams.	36 grams in 3 doses.
7.	4 drams per dose. Total, 4 eggs.	2 ozs. per dose. Total, 25 ozs.	40 grams.	70 grams with boiled rice. 100 grams in 3 doses.
	Also, 1 soft-boiled egg every four hours.			
8.	As above.	2½ ozs. per dose. Total, 28 ozs.	Do.	Do.
9.	Do.	3 ozs. per dose. Total, 1 quart.	Do.	Beef, same; rice, 200 grams; zwieback, 40 grams in 2 portions.
10.	Do.	Do.	Do.	Do.
11-14.	Add chopped cooked chicken, 50 grams; or ham, 50 grams, and butter 20 grams. Interval of feeding made two hours. Milk given in 6 oz. doses with ½ oz. of raw egg. Butter increased to 40 grams, and chicken or ham as above.			

Among 295 cases of gastric ulcer treated by Lenhartz 262 had had a hemorrhage before the beginning of treatment, and in 33 the stools contained blood; his total mortality, however, was 2.3 per cent., and only 18 cases had hemorrhage after the treatment was begun. Von Leube, replying to Lenhartz, reported that fully 90 per cent. of 627 patients were cured by his own method; 8.5 per cent. improved under it, and only 1 per cent. did not, while the mortality from hemorrhage was 0.3 per cent.

To check the tendency to **hemorrhage**, von Leube insists on keeping the **stomach absolutely at rest**. The patient is kept in bed and receives a single dose of 30 drops of a 1:1000 solution of **adrenalin**, supplemented by **bismuth**, an **ice-bag over the stomach**, and an injection of **morphine** to keep the stomach quiet (never for its pain-reducing properties). Food by the mouth is entirely abstained from, even milk. When the stool shows no more blood, and other signs also indicate cessation of the hemorrhage—usually in two or three days—he cautiously commences a liquid diet. The patients may lose weight at first, but more than make it up in the second week. The combination of **absolute rest in bed**, one glass of **tepid Carlsbad water** twice a day, **fasting**, **hot flaxseed poultices** renewed every ten or fifteen minutes for twelve hours (a wet linen cloth being substituted at night), and the special diet referred to is held to be indispensable.

A more recent addition to treatment is the **duodenal** method of **alimentation**. The Gross, Oeffle, or Einhorn tube is used. The food is delivered in the upper digestive tract without coming in contact with the ulcer-

bearing area. It is evident, however, that the cures by this method are not as many as by the methods of Lenhartz and von Leube. After a rather consistent use of the duodenal method I have abandoned it for the reason that, however little acid there may be in the stomach, it is not bound by protein foods present in the organ. Moreover, delivering a quantity of fluid in the duodenum through the tube reflexly excites a higher acidity in the stomach. Fluoroscopic observations showed that the tube, drawing taut against the lesser curvature, increases gastric motility.

Medicinal Treatment.—The drug most generally used is **bismuth subnitrate**, as mechanical sedative. **Bismuth subgallate** should be used in hemorrhage, and the **subcarbonate** in high acidity. By the use of bismuth pain is lessened, and vomiting and hemorrhage controlled; in a few days the stomach becomes more tolerant. Best results are obtained when the dose is large and taken into the empty organ. At least 30 grains (2 Gm.) should be given, either in plain boiled or barley water. Some recommend only one large dose in the morning, but, since in the average case the organ is quite emptied of bismuth in four to six hours, it is best to give it in doses of 2 to 4 Gm. (30 to 60 grains), at about the intervals mentioned. The occasional constipating effect may be minimized by adding *magnesia oxidi* (as below), suspending the bismuth in olive oil, giving **Carlsbad salts** each morning, or using enemas.

R Bismuthi subgallatis, vel subcarbonatis, vel subnitratis,

Magnesii oxidiãã 3x (40 Gm.).

Fiant pulveres no. x.

Sig.: 1 every five hours in barley-water.

To avoid nitrite poisoning, which may occur when the subnitrate is used continuously in large doses, it is best to employ the subcarbonate or subgallate from the first, or substitute one of these for it after a few days. The bismuth should be given steadily for two weeks, then in smaller doses as long as indicated.

Olive oil may be a valuable adjunct to relieve pain, vomiting and pyloric spasm. It may be given in 1- or 2-ounce (30 to 60 c.c.) quantities, and is a good vehicle for bismuth. Where olive oil by mouth induces nausea, it may be run down through the stomach-tube, but not in the early days of treatment.

At the end of the first week, **plain Carlsbad water** or **Vichy** may be given, one wineglassful at a time, and preferably at room temperature. **Carlsbad salts** may be used for constipation, but other salts often cause acute distress. The dose of Carlsbad salts is a teaspoonful in a glass of warm water, drunk slowly early in the morning.

Of great value in ulcer is **belladonna**, or **atropine**,—preferably the former. Controlling both secretions and motility, it can be given either with the **Lenhartz treatment** or when no food is given by mouth. It should be given steadily until its "physiological effects" are obtained. These are usually induced by 8-minim (0.5 c.c.) doses of the tincture, given at three- or four-hour intervals, in about two days. The dose should then be reduced to about one-third, and this amount continued as long as the patient remains in bed, avoiding a return of the "physiological effects." In acute gastric ulcer with marked vomiting of sanguineous acid fluid or

intense boring pain after feeding, the results are often striking.

The chief drugs used as astringents to promote healing are **silver nitrate** and **ferric chloride**. The former also advised as antacid, is given in pill form, $\frac{1}{4}$ to $\frac{1}{2}$ grain (0.015 to 0.03 Gm.) at a dose, or in solution with a little **sodium bicarbonate**— $7\frac{1}{2}$ to 15 grains (0.5 to 1.0 Gm.). Boas used silver nitrate in solution, 4 grains to 4 ounces (0.25 Gm. to 120 c.c.).

Duodenal alimentation proved extremely successful in gastric ulcer. The writers introduce the tube into the duodenum at night and feed with 150 Gm. (5 ounces) of tepid milk daily, then 200 Gm. (7 ounces). Yolks of eggs are given, up to 4 a day. After every feeding a saline injection is administered. Relief of the pain is the first effect obtained. Pages and Ibañez (Vida Nueva, Apr., 1918).

In von Leube's method, during the patient's ten-day stay in bed, the **epigastrium** is washed with alcohol and **mercury bichloride solution**, **boric ointment** next applied on a thin cloth, and over this a **hot flaxseed poultice** renewed every fifteen minutes for ten hours during the day, and a wet compress during the night. After the tenth day, a **flannel abdominal binder** is worn during the day, and for three weeks a simple **cold compress at night**. During convalescence, the patient is required to **rest** completely for two hours **after meals**. Contraindications for poulticing are menstruation and recent hemorrhage (within three months); in recent hemorrhage an **ice-bag** is substituted. One pint (500 c.c.) of **Carlsbad water** is drunk slowly in the morning for one month, and **alkaline waters** during the day. **Bismuth** and **sodium bicarbonate** may be used. In the first ten days the

diet consists of boiled milk, Leube's meat solution, and soft, unsweetened zwieback. In the next week, rice or sago soups, boiled with milk or white of egg, and soft-boiled or raw eggs are used. Later on tender meats are given, and after the fifth week a careful ordinary diet. Constipation is treated by **enemata of tepid water** or **Carlsbad salts**, or, after the eleventh day, by 1 dram (4 Gm.) of a powder consisting of **powdered rhubarb**, 8 parts; **sodium sulphate**, 6 parts, and **sodium bicarbonate**, 3 parts.

Special Treatment of Symptoms.—

Pain, if severe, may rarely require **morphine** in the first couple of days; usually, **belladonna**, with or without **codeine**, is sufficient. **Chloral hydrate**, as a sedative and antiseptic, would seem too irritating, even in 2- to 5-grain (0.13 to 0.31 Gm.) doses. **Orthoform** or **anesthesin** may be given in severe cases. Usually, however, **rest** and **diet** having been instituted, a **wet compress over the abdomen** is sufficient to control the pain. A so-called "**sweat bandage**" may be used: A large soft towel is soaked in cold water, wrung out, folded lengthwise, and wrapped round the patient's waist; over it rubber sheeting or oiled silk is placed, and then a dry towel to bind these in place. This bandage is changed two or three times in twenty-four hours. An **ice-bag** or **flaxseed poultice over the epigastrium** may be substituted.

Vomiting, for which **bismuth**, **belladonna**, **ice**, and **opium suppositories** are recommended, usually subsides after a few days of routine treatment. When it is more severe, apply a **mustard plaster to the epigastrium**, immediately followed by an **ice-bag** when the skin is well reddened.

Anemia may be treated with **albuminate of iron**, as Ewald suggests, by adding 1 fluidram (4 c.c.) of a 2 per cent. solution of **iron sesquichloride** to 2 fluidounces (60 c.c.) of albumin-water. One or two teaspoonfuls of **Liq. ferri albuminati** (N. F.), or **Liq. ferri peptonati cum mangano** (N. F.), may be given three times daily in a little water. In the late treatment:—

R *Arseni trioxidi* gr. ss (0.03 Gm.).
Ferri sulphatis ʒij (8.0 Gm.).
Potassii carbonatis . ʒj (4.0 Gm.).

Fiant pilule no. xxx (soft).

Sig.: Take 1 pill three times a day.

For gastric hyperacidity, **bismuth subcarbonate**, **belladonna**, and the **mineral alkalies** and **alkaline mineral waters** are used. Though separate use of these is generally advisable, the following may be employed:—

R *Belladonnæ pulveris* ... ʒss (2 Gm.).
Sodii carbonatis ʒj (30 Gm.).
Magnesiæ oxidi ʒx (40 Gm.).
Talcii pulveris ʒss (15 Gm.).

Pone in chartulas no. xxx.

Sig.: Take 1 powder in water every four hours.

Or, the following formula of Stockton's may be used:—

R *Cerii oxalatis* ʒiiss (10 Gm.).
Bismuthi subcarb. ʒv (20 Gm.).
Magnesiæ carbonatis .. ʒx (40 Gm.).

Fac pulverem.

Sig.: Take ½ teaspoonful every four hours.

Abundant hemorrhage may require a hypodermic of **morphine**. In less severe forms, **adrenalin chloride** solution, 1 to 1000 (10 to 20 drops), three or four times a day, may be effective. **Bismuth subgallate**, **absolute rest** and **quiet**, and the **sucking of small pieces of ice** may answer. Ewald practises **ice-water lavage**, and others recommend **gelatin-water**; death from hemorrhage occurs in only about 3 per

cent. of cases. If the pulse is very small, anemic murmurs appear, or cerebral anemia occurs, **normal saline infusion** at body temperature, at least 1 quart (liter) at a time, deep into the subclavicular region or under the breast in the female is indicated; in a few cases, direct **transfusion of blood** is necessary; when the patient shows constitutional effects from constant, moderate bleeding, Murphy's continuous proctoclysis.

Gastric lavage is imperative if there is some fermentation—usually when stenosis or marked atony exists. Kaufmann advises lavage in acute hemorrhage, claiming that gastric contraction occurs upon evacuation.

Perigastritis usually demands prolongation of the **treatment in bed**, and possibly **opium suppositories**, or **cocaine internally**, to relieve pain, *e.g.*,

℞ *Opii pulveris* gr. xxv (1.6 Gm.).
*Bismuthi subnitrat*is ʒj (30.0 Gm.).
Cretæ præparata... ʒvj (24.0 Gm.).
Sodii bicarbonatis.. ʒj (30.0 Gm.).

Pone in chartulas no. xxx.

Sig.: Take 1 powder every four hours.

Sippy's treatment consists essentially in accurately protecting the ulcer from the gastric juice until healing can take place.

The vast majority of gastric, and more particularly duodenal, ulcers now treated surgically can be readily and more quickly cured by this method. The digestive action of the gastric juice is rendered inert from 7 A.M. to 10.30 P.M. In addition, if an excessive night secretion is detected, this is removed until the irritability of the gastric glands has subsided, by aspiration 2 or 3 times each night, if necessary. Usually after 3 or 4 days this night secretion then disappears. Subsequently the normal quantity (about 10 c.c.) of gastric juice in the stomach at night is left undisturbed.

Neutralization of the acid is accomplished by frequent feedings and by alkalies in regulated quantities. The patient remains in bed from 3 to 4 weeks. Three ounces of equal parts milk and cream are given every hour from 7 A.M. until 7 P.M. After 2 or 3 days soft eggs and well-cooked cereals are gradually added, until after 10 days the following is being given: 3 ounces of milk and cream every hour; 3 soft eggs, 1 at a time, and 9 ounces of a cereal, 3 ounces at 1 feeding. Cream soups, vegetable purées and other soft foods may be substituted now and then, as desired. The total bulk at 1 feeding should not exceed 6 ounces. Jellies, marmalades, custards, creams, etc., are permissible. Preliminary starvation is unnecessary. In addition to giving an alkaline powder midway between feedings, the powders are continued every half hour after the last feeding, until 10 P.M. Gastric ulcer with stagnation is usually controlled by feeding every hour and giving a powder of 10 grains (0.6 Gm.) each of heavy calcined **magnesia** and **sodium bicarbonate**, alternating with a powder of 10 grains (0.6 Gm.) of **bismuth subcarbonate**, and 20 or 30 grains (1.3 or 2.0 Gm.) of sodium bicarbonate, midway between feedings. Cases with stagnation of food and secretion longer than 2 months usually require more of the alkalies. Sippy (Jour. Amer. Med. Assoc., May 15, 1915).

Surgical Treatment.—The ratio of failures of medical treatment in ulcer has been reported all the way from less than 1 per cent. up to 22 per cent. Even in the best hands, failure occurs, particularly in perforations, the sequels, and chronic ulcer. Surgical interference, on the other hand, shows a most gratifying increase of successes each succeeding year. Moynihan's series of 251 **gastroenterostomies**, etc., for simple chronic gastric or duodenal ulcers, mortality 3.5 per cent., and Mayo Robson's

210 gastroenterostomies, etc., with a mortality of 3.8 per cent., may be taken as the latest authentic figures. Among average surgeons future years will show a lower rate of mortality than to-day exists (5 to 20 per cent.). Thus it seems logical for the internist to refer to the surgeon those cases which do not progress under careful medical treatment.

In cases of copious hemorrhage, surgery often fails. Von Leube found uncontrollable hemorrhage the cause of death in only 1 per cent. of his cases of ulcer, and surgery, even at best, cannot offer better results than this. Thus, surgery is indicated only for a continuation of recurrent hemorrhage after careful treatment.

Perforation, on the other hand, always requires surgical procedure, the percentage of recoveries from medical treatment being only about 5 per cent., while that of surgery, when instituted early enough, is over 65 per cent. In favorable cases, a **gastroenterostomy** should follow the closure of the perforation, for by it rest of the stomach is permitted, and the secretion becomes more nearly normal. If the general condition of the patient is not good, gastroenterostomy should not be done.

A diagnosis of perforation of the upper abdomen having been made, the patient should be kept with shoulders down and hips raised until the operation. No food is to be allowed, and peristaltic rest should be secured by application of cold to the upper abdomen, and perhaps the use of opiates before operation. If shock is severe, **intravenous saline infusion** is of value. The operation should be as brief as possible. Murphy advises **continuous warm saline proctoclysis**

when the patient is returned to bed. (For technique see this volume, page 195.) Passing the tube between two hot-water bags at the side of the bed is sufficient for keeping the fluid warm.

Hour-glass contraction requires surgical treatment. A communication can be formed between the two sacs by means of **gastroplasty** and **gastrogastrostomy**, **gastroenterostomy** being added if indicated. When the contraction is in the pyloric region and partial, the ideal operation is **partial gastrectomy**. The average mortality of the operations for hour-glass stomach is about 17 per cent.

Where gastric atony develops as a post-ulcer condition secondary to pyloric stenosis, a special diet consisting of fluids, semisolid foods, and the solid foods in finely comminuted form should be given at first. The meals should be small and frequent. If relief does not follow: **partial gastrectomy** and **gastroenterostomy**.

Incessant pains from old perigastric adhesions may be temporized with by medical measures and the use of **potassium iodide** or **syrup of hydriodic acid**. When these fail, and debility, anemia, etc., increase, surgical treatment is indicated.

In persistent gastrosuccorhea and hyperesthesia or gastralgia following ulcer, operation should be withheld until thorough medical treatment, with strict *régime* and X-rays have been tried. A return to the **rest treatment** for two weeks or so is sometimes desirable. **Partial gastrectomy** is the operation of first choice, and **gastroenterostomy** the second. The same considerations apply in cases of recurrent bleeding.

True chronic ulcer is generally a surgical condition. **Special dieting, bismuth, belladonna, rest, the X-rays,** and the **tonics** proving a failure, mixed treatment will occasionally give surprising results. As a rule, because of adhesions and engorgement, the only feasible operation is **gastroenterostomy**.

In duodenal ulcer all surgeons, and most internists, now favor operative treatment. Yet good grounds exist against immediate surgical treatment for all cases. Accepting Mayo's figures of 401 duodenal to 201 gastric ulcers operated upon among 621 cases, duodenal ulcer is met with twice as often from the surgical standpoint as gastric ulcer. From autopsy findings I am inclined to believe that many times more ulcers occur in the stomach than in the duodenum, and that the majority of these heal. Further, I believe that at least one-fourth of the duodenal ulcers heal under medical means, *i.e.*, three weeks of **bed and diet** treatment, and about six months of careful dieting. Therefore, in unperforated duodenal ulcer, however long its previous course, I apply medical treatment first. In most cases, about a week of this removes the symptoms. After the third week I place them on my regular diet for reducing excessive secretion, and continue this for about six months, making fecal examinations for blood, etc.

Before the patient goes to bed, it should be explained to him that surgical intervention may be necessary at any time. If he prefers the operative risk to prolonged medical treatment, he is operated upon at once. After the bed treatment, I again mention the possibility that operation

may later be required. After six months, if all has been well, regular foods are allowed. Should the symptoms not subside during the bed treatment, or the bleeding continue after the first week, or there be a return of the pain, or if there is amelioration only of the local symptoms, operation is advised at once, preferably **posterior gastroenterostomy**.

Carcinomatous change is always a surgical condition. Excision of the diseased area, adhesions, and enlarged lymph-glands is necessary.

When results from medical treatment are poor, the patient should be assured that nothing can be done by internal means, and the advisability and lack of danger of an exploratory incision dwelt upon. Only thus is it possible to get the majority of patients to consent to operation.

A number of cases of **gastroenterostomy** later develop enterocolitis. To obviate this, it is important to maintain the **diet** for hyperacidity for some weeks or months, then, to advise the following: All foods are to be fresh and cleanly cooked and served, and no foods eaten that have been standing cooked some hours. The mouth should be **cleansed with plain warm water**, preferably with a little **sodium bicarbonate** dissolved in it, **before and after meals**, and, when possible, at other times. Four meals a day, moderate in amounts, or three meals a day with small supplemental meals between them and before retiring, are advisable. Thorough cooking, fine comminution of the foods, with complete mastication and slow eating, are necessary. Food should not be eaten during fatigue. Rest in a reclining position one hour after the main meals is de-

sirable. No condiments should be allowed, and the use of salt restricted. Food should be soft or semisolid.

Where hemorrhages occur in ulcer, direct surgical attack of the ulcer is necessary, gastroenterostomy failing to protect. Among 2875 cases operated on for duodenal ulcer at the Mayo Clinic, the mortality was 1.6 per cent. About 20 per cent. of these had had hemorrhage before operation, and 12.7 per cent. after operation. Among 863 cases of gastric ulcer the operative mortality was somewhat over 3 per cent., and 8 per cent. had gross hemorrhages after operation. Only 2 patients, however, died from hemorrhages after operation. The other symptoms were almost always completely relieved by gastroenterostomy, but not the bleeding. Excision combined with gastroenterostomy gave the desired protection against hemorrhage. The actual cautery is the safest and surest method of removing the ulcer in most instances. Balfour (*Amer. Med. Assoc.; N. Y. Med. Jour.*, June 28, 1919).

SYPHILIS OF THE STOMACH.

Judging from experience in post-mortems on syphilitic individuals gastric syphilis would seem to be a very rare affection, though of late years the frequency of authentic cases has been constantly on the increase. It is probably met with in about 1 per cent. of autopsies on syphilitics.

PATHOLOGY.—The disease manifests itself in three ways, viz.: diffuse syphilitic gastritis, syphilitic ulcer, and gumma. To these may be added the sequels, perigastric adhesions or pyloric thickenings causing stenosis. A combination of the three lesions is often met with.

Diffuse syphilitic gastritis, essentially chronic, is commonly an accompaniment of syphilis of other abdominal organs or of gastric gum-

mata. Syphilitic lesions usually co-exist in the liver, spleen and pancreas. The diffuse condition does not differ histologically from ordinary chronic gastritis, in which profuse round-cell infiltration exists.

There are many reasons for believing that gastric ulcers of syphilitic origin do occur, probably by rupture of gummata or round-cell invasion about and in the walls of the blood-vessels, stopping the blood-supply.

Gummata, single and of large size, or coalescing, to form deposits palpable from without, are no doubt very rare. Gummata are often situated in the pyloric region or along the lesser curvature, and are seen as reddish swellings or flattened elevations in the submucosa. The mucosa is thickened, soft, glistening, and yellowish, with small ulcerations.

SYMPTOMS AND DIAGNOSIS.

—The diagnosis is based on the history, late syphilitic manifestations, the Wassermann test, and the results of specific therapy. The clinical picture does not differ especially from those of non-specific gastric affections. The condition may occur early in congenital syphilis, along with saddle nose, prominent forehead, lines about the mouth, Hutchinson teeth, interstitial keratitis, etc. If there is a history of many abortions, hydramnios, or marasmic, short-lived infants, it may be diagnosed or, at least, suspected. In the acquired form thorough treatment over years does not always cure the condition.

There may be an achylic gastric content with much mucus; dilatation of the organ, with stagnation; a long-standing gastric ulcer in respect of which alcoholism, chlorosis, arteriosclerosis, tuberculosis, and other

causes can be eliminated, and which has not bled nor recovered under ulcer treatment; a long-standing, small, irregular, movable pyloric growth, or an unaccountable, chronically enlarged spleen with ascites.

There is one type of case which closely simulates malignant disease. There may be most severe gastric pain, uninfluenced by ingestion of food and worse at night. Debility and anemia may be pronounced. The stomach usually shows retention and absence of hydrochloric acid and pepsin. The epigastrium is usually very tender, and after some months a pyloric tumor is noted. Chronicity is a distinguishing feature, some cases being ill four to eighteen years.

TREATMENT.—If the diagnosis is doubtful or the “therapeutic test” merely to be tried, smaller amounts of **mercury** and **iodides** may suffice at first. The **protiodide** and **bichloride of mercury** may be given by mouth for a short time, but when benefit is being derived they should be given by injection or inunction. Hypodermic use of 10 to 30 minims (0.6 to 1.8 c.c.) of a 0.4 per cent. **mercury biniodide solution** in olive oil, or 10 minims of a 10 per cent. **mercury salicylate solution** in albolene, every third or fourth day, is efficient. By mouth, **calomel**, 1 grain (0.065 Gm.), with **powdered opium**, $\frac{1}{3}$ grain (0.02 Gm.), three times a day is of value.

Internal syphilis in adults being mostly late tertiary, the **iodides** should be given, in doses of between 30 and 60 grains (2 and 4 Gm.) daily, at mealtimes. When, in a gastric case, benefit is being derived, the daily amount should be gradually increased to 150 grains (10 Gm.), or more, until the symptoms abate, after

which the drug should be continued at about the first-mentioned quantity or less. The insoluble mercury salts (**calomel** or **biniodide**) are best given independently. Dietetic, tonic and hygienic measures are also in order.

Instead of mercury and iodide, **salvarsan** or **neosalvarsan**, may be employed, preferably intravenously.

TUBERCULOSIS OF THE STOMACH.

This is usually secondary to pulmonary disease, resulting from constant swallowing of infected sputum, yet cases of primary gastric tuberculosis are also reported.

ETIOLOGY.—Tuberculous ulcers of the stomach are comparatively rare, being found in about 2.3 per cent. of autopsies upon tuberculous patients. Presumably, many of the bacteria are destroyed by the gastric juice. Motor insufficiency and chronic gastric catarrh, particularly gastritis granulosa, in which there is an increase in the lymphoid follicles, are among the most important predisposing factors.

PATHOLOGY.—Five varieties of gastric tuberculosis are described: (a) The ulcer, sometimes single, often multiple, small, irregular, elevated, somewhat undermined, with indurated margins and rough base, and in which tubercles may be noted; rarely it erodes a large vessel. (b) Miliary tuberculosis, hematogenous in origin, manifest as millet-seed formations on the peritoneal surface or along the vessels. (c) Solitary tubercles, rare, probably due to local infection from sputum. (d) Tumor-like masses, generally near the pylorus, usually due to large tuberculous deposits, perhaps adenomatous. As the pylorus is rela-

tively rich in lymphoid tissues, probably a number of cases of inexplicable stenosis are tuberculous in origin. (c) Tuberculous cicatricial pyloric stenosis from more or less healed lesions or contraction of re-sulting perigastric bands (Martin).

A number of the small tuberculous ulcers usually coexist on the lesser curvature and posterior wall, being flat, with a floor composed of yellow or gray tubercles, and a thickened submucosa. Scrapings show bacilli, and giant cells are occasionally met with in the underlying tissues. Less often large single ulcers of the indolent type are seen. In addition, the ileum, colon, spleen, and pancreas may be similarly affected. Where tubercles exist on the peritoneal surface, adhesions with the mesentery and omentum are common.

SYMPTOMS AND DIAGNOSIS.

--There are no distinctive symptoms of gastric tuberculosis, excepting possibly the chronicity of its course. Like the syphilitic ulcers, tuberculous ulcers are not so liable to hemorrhage as the simple, malignant, or chronic forms. If there be evidence of tuberculous disease in parts of the body other than the abdomen, tuberculous gastric disease should be thought of. Pain is often severe. If pyloric stenosis exists and a tumor is palpable, one must think of local tuberculosis as well as malignant disease. Primary gastric atony may follow infectious diseases, such as typhoid fever and tuberculosis. Most instances of dilated stomach in these diseases must be considered due to toxemia and subnutrition rather than local gastric disease.

Tubercle bacilli in the stomach are not diagnostic, as in lung tubercu-

losis they are swallowed. Significant, however, may be a persistent, slight, unaccountable fever, with its highest point about 4 P.M.; steady loss in weight, cough, hemoptysis, dyspnea, pleurisy, sputum, and physical signs.

In ulcers of the stomach or intestines which fail to heal, the tuberculin test offers the only possibility of diagnosis. Koch's tuberculin, standardized, in ascending doses of 0.001, 0.003, 0.005, 0.008 and 0.01 c.c., well diluted, should be given. The temperature reaction (37.8° C. or 100° F. or more) should be watched for from eight to twenty hours after the injection, and at intervals for seventy-two hours afterward. The von Pirquet or ophthalmic tests may also be employed.

TREATMENT.—Persons with lung tuberculosis should be warned against swallowing sputum, and advice given to cleanse the mouth and fauces thoroughly before eating and drinking. The active treatment consists in applying the usual antituberculous hygiene and diet. Careful therapeutic use of **tuberculin** seems justifiable. It should only be employed, however, in the afebrile cases and when the state of general nutrition permits. The dose should be begun at 0.0001, or, better, 0.00001 c.c. of the O. T. preparation, given every third day, and gradually increased until the limit of tolerance is reached. The B. F. tuberculin has been advised for the febrile cases. The treatment should be continued for at least three months, along with the **hygienic-dietetic treatment**.

In any persistent gastric ulcer case with Wassermann test negative and tuberculin test positive, if the general

medical treatment of tuberculosis proves a failure, providing the general condition warrants surgical procedure, an operation should be performed. If an ulcer be found, **excision** is the procedure of choice.

PSEUDOMEMBRANOUS GASTRITIS.

In diphtheria, anthrax, typhus, and pneumonia, a pseudomembranous gastritis may rarely occur. Diagnosis is impossible unless the membranes are vomited or removed by lavage. Several instances of what appeared to be true diphtheritic gastritis have been reported. These always accompanied faucial or nasal diphtheria.

BENIGN TUMORS OF THE STOMACH.

These tumors are rare, most palpable growths being carcinomatous. Among the benign are adenoma, papilloma, myoma and fibromyoma, lipoma, myxoma, lymphadenoma, polypi, and retention cysts, to which may be added gastroliths and foreign bodies, the thickenings of the pylorus (hypertrophic stenosis), and diverticulum of the stomach.

PATHOLOGY.—Adenomata, as a rule, occur as small, white, translucent, irregular growths of tubular structure, and **papillomata** as wart-like or pedunculated growths of a finer consistence. Adenomata may closely simulate adenocarcinoma.

Myomata and Fibromyomata.—The myomata develop in the muscular layer. They are often numerous and of small size, forming slight elevations of the mucous membrane, but may be single, large, and perhaps pedunculated. The fibromyomata are larger, up to the size of a pigeon's

egg. As a rule, the overlying mucous membrane is normal.

Lipomata.—Small lipomata are occasionally seen in the submucous coat, forming projections covered with attenuated mucous membrane. More rarely the tumor separates the muscular fibers, forming small hernias under the serosa. Orth has observed pedunculated lipomata growing from the serosa, and a large tumor of this kind may cause digestive disturbance.

Myxomata are seen as small, jelly-like deposits containing much mucin, usually in the form of myxolipoma, myxofibroma, and myxoadenoma. Their cut surface is pale grayish or reddish white in color. There is generally a thin capsule. These grow from the connective tissue in the submucous or intermuscular tissue. They enlarge slowly, and rarely attain considerable size in the stomach, though when mixed with sarcoma-cells they may grow very rapidly. In some instances they are pedunculated (mucous polypi), and may be numerous in the pyloric region. Their formation has been attributed to chronic gastritis. Submucous myxoma is not very rare, occurring generally in middle life, and often in the male sex.

Lymphadenomata, because of their association with sarcoma, are the chief benign tumors. The benign form (lymphoma) is seen as small, scattered nodules, grayish-white and soft, yielding a milky-white juice. They are often found in the internal organs in Hodgkin's disease. They are often found in the internal organs in Hodgkin's disease. They develop in the mucosa and submucosa, project into the lumen, and commonly ulcerate, possibly with resulting fatal hemorrhage. At times

lymphomata become malignant, infiltrating nearby structures, involving the lymphatics, and infecting distant parts. These are lymphadenomata.

Retention cysts are met with in the polypoid forms of chronic gastritis (gastritis polyposa). Gastric dermoid cyst and multilocular lymphangioma are very rare. Most gastric cysts are myxomatous.

Gastroliths and foreign bodies are very rare. They are most often seen in the insane, but may be met with in instances of vicious habits, such as continued swallowing of hair, fiber, or unusual solid articles, and very rarely in form of collections of vegetable detritus. These may almost fill the cavity of the organ.

A few cases of diverticulum of the stomach are on record, being usually met with on the distal side of some contracting cicatrix or perigastric band. They may be large, and are always free of external adhesions.

Hypertrophy of the pylorus occurs in two clinical types: the acquired hypertrophic stenosis of the pylorus accompanying a hypertrophic gastritis, and the congenital type. Unless the obstruction is removed, the consequences may be, and generally are, as serious as those of pyloric stenosis due to malignant disease. The thickening of tissue is greatest at the pylorus, though the entire stomach may be smaller from general involvement. The pyloric wall may be 2 or 3 centimeters in thickness. The disease occurs chiefly in persons between 20 and 40 years of age, and in males somewhat oftener than in females. Chronic alcoholism is a prominent factor in most cases. The glandular coat is commonly much ulcerated in the pyloric region.

SYMPTOMS AND DIAGNOSIS.

—Where benign tumors are of small or moderate size, the diagnosis is usually made only after death. Where they are large, an epigastric tumor may be palpable. In large pedunculated growths, the pylorus may act as a ball valve. Here the growth may cause a secondary atony of the stomach, the extraction of mixed meals seven, eight, or nine hours after their ingestion affording evidence of stagnation. Gastric secretion is not disturbed, or a high acidity may exist.

Hematemesis with occult blood in the stools may be observed in lymphadenoma. Saline gastric instillations may yield pus-cells and increased bacterial flora; the gas product may be over 2 per cent.

Of the foreign bodies, "hair balls" are most common. A soft, movable mass may be discovered. Emesis and excessive eructations are common. A history of chronic digestive disturbance is the rule. In these cases the gastroscope is of value, both for diagnosis and removal. It may also well serve similarly in pedunculated tumors. Cases of persistent ingestion of needles have been reported in which needles were found in various parts of the abdomen, even travelling to the extremities. Large quantities of metallic articles are sometimes accumulated in the stomach. Where the habit of swallowing such bodies has existed for some time, it is often fatal.

In hypertrophic stenosis the history is that of chronic gastritis, and a subchlorhydric, anachlorhydric, or achylic condition is the rule. A small, hard, globular mass (thickened pylorus) may be palpable in the mid-

line above the umbilicus, or the entire stomach may feel stiff and unyielding. Fullness, pressure, pain, pyrosis, and eructations are generally present, with rather steady vomiting as the case advances. The appetite may not be disturbed. Small amounts of blood are usually found in the test-meal and fecal examinations, and the X-rays, showing a small, triangular stomach, are valuable in diagnosis. Differentiation from stricture due to carcinoma or ulcer requires exhaustive examination. These cases advance slowly; stagnation may not occur until very late.

In the diverticula cases a history of severe epigastric pain after eating, followed by vomiting of a very bitter substance with immediate relief, and a disinclination to take solid foods, are present when the sac is in the pyloric region. Physical examination is usually negative, but the X-rays would be helpful.

TREATMENT.—Small benign growths causing no symptoms require no special treatment. In the case of larger pedunculated growths or foreign bodies producing symptoms and not situated in the inaccessible pyloric region or lesser curvature, removal through a gastroscope may be attempted. When such removal is impossible, the growth is in the gastric wall, or hypertrophic stenosis exists, laparotomy is in order. The danger of recurrence being very slight, the organ can be at once closed. In growths in the stomach-wall more or less removal of gastric tissue is necessary, and a gastroenterostomy may be required.

In moderate cases of hypertrophic stenosis palliative treatment answers, the patient abstaining from alcohol,

irritating and hard foods, and tobacco, and using milk, soft eggs, purées, etc., when there is HCl secretion, or chiefly well-cooked, soft carbohydrates and pancreatin when there is not. Regular stomach lavage with hydrastis solution or dilute hydrochloric acid is of value, particularly when gastric retention exists. In the more severe cases, when emaciation is progressive and stagnation exists, medical treatment failing, operation should be advised. Where only the pylorus is thickened, pylorotomy and pyloroplasty are ideal; if the entire stomach, a free gastroenterostomy should be performed. Should the organ be contracted so high as to preclude a posterior gastroenterostomy, pylorotomy or the Finney operation may alone be possible. In high-degree stenosis, the operation should not be postponed a single day. After the stenosis has been relieved, the case requires the additional dietetic, medicinal, and mechanical treatments described under Chronic Gastritis.

In cases of gastric diverticulum the sac should be excised, and the two lateral portions of normal stomach-wall brought together.

ANTHONY BASSLER,
New York.

STOMACH, INJURIES AND SURGICAL DISEASES OF. See ABDOMEN, SURGERY OF: ABDOMINAL INJURIES.

STOMATITIS. See MOUTH, DISEASES OF.

STOVAINE.—Stovaine, an unofficial local anesthetic and substitute for cocaine, is chemically benzoylethyl dimethylaminopropanol hydrochloride: $\text{CH}_3\text{CH}_2\text{C}(\text{C}_6\text{H}_5\text{COO})\cdot(\text{CH}_3)\text{CH}_2\text{N}(\text{CH}_3)_2\cdot\text{HCl}$. It is closely related chemically to alypin.

It was first made synthetically in 1903 by Fourneau, a French chemist, and named in his honor, the English translation of *fourneau*—a stove—being utilized as a more euphonious basis than the French word in coining the new term, *stovaine*.

Stovaine crystallizes in small scales. It is very soluble in water and methyl alcohol, less freely in absolute ethyl alcohol, of which 5 parts are required to dissolve it. Aqueous solutions of stovaine are faintly acid to litmus. When in solution the drug is decomposed by alkalis, even if very dilute, and is precipitated by the alkaloidal reagents in general. The drug is held to be stable on moderate heating, so that solutions of it may be sterilized at 115° C. The experience of W. Wayne Babcock with it in spinal anesthesia, however, has afforded evidence to the effect that, even at 100° C., the stability of the drug is not absolutely complete, and that, to avoid possible unpleasant after-effects in this delicate form of anesthesia, solutions of the drug should be sterilized only by the intermittent method, at temperatures not exceeding 65° C. (149° F.). Where the drug is used in small amount in ordinary local anesthesia, such care in sterilization is, perhaps, unnecessary.

PHYSIOLOGICAL ACTION.—Like cocaine, stovaine is capable of acting not only locally, but on the central nervous system. Large doses of stovaine, administered subcutaneously in animals, at times induce a general analgesia without other nervous effects, but more frequently such manifestations as motor inco-ordination, tonic and clonic spasms, and paralysis of the extremities, followed, at times after a period of coma, by respiratory paralysis and death. The toxicity of stovaine is, however, two or three times less than that of cocaine. According to Braun, the lethal doses of cocaine and stovaine per kilogram of body weight when injected subcutaneously in dogs are 0.05 to 0.07 Gm. and 0.15 Gm., respectively; according to B. Wiki, the corresponding figures in guinea-pigs are 0.045 and 0.11 Gm., respectively. Stovaine in moderate dosage tends to excite the heart-muscle; the blood-vessels are at first dilated, but the resulting tendency to reduction of blood-pressure is of short

duration, the pressure soon returning to normal. As compared to the action of cocaine this vasodilator property is an advantage, the tendency to syncope due to vasoconstriction so often noted with cocaine being absent with stovaine.

Locally, stovaine exerts an anesthetic action practically equivalent to that of cocaine, *i.e.*, solutions of the two drugs of like percentage produce nearly equal effects. Stovaine differs from cocaine in being a local vasodilator rather than a vasoconstrictor. This vasodilator effect is not sufficient, however, to cause any unusual amount of bleeding in operations under stovaine anesthesia, and may, in fact, be advantageous in that no troublesome secondary oozing, as sometimes witnessed after cocaine, need be anticipated (Gambini-Botto).

POISONING.—Stovaine is a far safer drug, from the standpoint of constitutional effects, than cocaine. Reclus, among 100 cases in which it was used for local anesthesia, observed slight pallor and pre-cordial oppression in but one instance. A dose of 3 grains (0.2 Gm.) may be used without risk, and theoretically, one might use as much as 7½ or 9 grains (0.5 or 0.6 Gm.) (Kendirdjy), though such amounts are not in practice required.

Stovaine is, however, undoubtedly disadvantageous, in that it acts unfavorably, especially in the more concentrated solutions, such as 2 to 10 per cent., on the vitality of the tissue cells with which it is brought in contact. Instances of local necrosis after its use in local anesthesia have been reported, and Sinclair asserts that it interferes with the processes of tissue repair. With 1 per cent. or weaker solutions, the chances of unfavorable effects of this kind are, it would seem, very slight, but the drug does, in general, cause a more or less persistent tissue hyperemia which is not met with after cocaine or other cocaine substitutes, such as beta eucaine and, in particular, novocaine.

THERAPEUTICS.—Aside from its use in spinal anesthesia, which has already been considered (see SPINAL ANESTHESIA), stovaine is, by most observers, held inferior to some other local anesthetic drugs—especially novocaine—on account of the irritant effects referred to in the

preceding section. That the drug may be used, however, without anticipating any special difficulty from this source—*e.g.*, where novocaine is not available—was illustrated in its extensive employment in the few years following its discovery, before the introduction of novocaine. Gambini-Botto performed about 200 operations under $\frac{1}{2}$ per cent. stovaine local anesthesia, including 79 operations for **hernia**, 24 for **hydrocele**, 18 for **varicocele**, 6 for **varicose veins**, 4 for **anal fissure**, etc. Arnezzi (1905) used stovaine or stovaine-epinephrin in 44 cases with satisfactory results, and Reclus, the most eminent French pioneer in local anesthesia, used stovaine for a time in preference to cocaine, though eventually abandoning it in favor of novocaine. The writer took part in the **removal of a lipoma** from the shoulder of a female patient under stovaine, and a perfect anesthesia was secured with this drug. Stovaine may also be used with good results in $\frac{1}{2}$, $\frac{3}{4}$, or 1 per cent. solution in such operations as the **removal of a wen**, or other **cutaneous or subcutaneous tumor**, the excision of a **lupus nodule** or **chancroid** lesion, the extraction of a foreign body, the opening of an abscess, etc. Conduction, *i.e.*, nerve-trunk, anesthesia with stovaine may be usefully applied in operations for **ingrown toe-nail**, **hammer-toe**, **paronychia**, **phalangeal dislocation**, **foreign bodies in the fingers**, **exostoses under the nails**, and **circumcision**. To procure local vasoconstriction during the operation, **epinephrin** may be added to the stovaine solution. Arnezzi used 1 minim (0.06 c.c.) of 1:1000 epinephrin solution to every 3 c.c. (48 minims) of $\frac{1}{2}$ per cent. stovaine, and Blondeau, 4 drops of epinephrin to every 2 c.c. (32 minims) of 1 per cent. stovaine. The methods of inducing local anesthesia with stovaine are identical with those followed in using other similar drugs (see COCAINE and NOVOCAINE).

In dental practice a 1 or $1\frac{1}{2}$ per cent. solution of stovaine, with a little epinephrin added, may be applied to the surface of the gums, then injected into the latter in a plane parallel with the lateral surfaces of the teeth. In ophthalmology 1 to 4 per cent. solutions have been used for instillation and a 1 per cent. solution

for subconjunctival injection. Instillation of 5 drops of a 4 per cent. solution induces some blepharospasm, smarting, lachrymation, and slight conjunctival congestion, followed in 2 or 3 minutes by anesthesia equivalent to that induced by cocaine and permitting of cauterization of **corneal ulcers**, **extirpation of chalazia**, **pterygia**, or small **epitheliomata**, operations for **trichiasis**, and **muscle transplantations** (Scrini). The anesthesia, after 2 or 3 applications, generally lasts for about half an hour (Stephenson). After 1 application it remains complete for 8 to 10 minutes, then gradually diminishes (Scrini). Mydriasis is less marked than with cocaine. Accommodation and the light and convergence reflexes are not affected. In the deeper operations subconjunctival injection is, of course, required to secure anesthesia of all the tissues operated upon. A 1 per cent. solution may be instilled to relieve discomfort in **blepharitis**, **conjunctivitis**, **phlyctenular ophthalmia**, **iritis**, and **episcleritis**.

Stovaine may also be used in nose, throat, and ear operations, in the same manner as cocaine. D. McKenzie used it in 5 to 20 per cent. solutions, and found a 10 per cent. solution strong enough for most cases. In 57 cases there were no complaints or toxic phenomena. When the application of the drug exceeded 20 minutes in duration slight ulceration was produced which, however, readily healed.

S.

STRABISMUS.—Squint; heterotropia.

DEFINITION.—The condition in which both eyes do not look toward the same point; but when one eye fixes a certain point the other is turned elsewhere.

SYMPTOMS.—The false position of the eye that is not turned toward the object looked at is usually noticed on casual inspection, and constitutes a very disagreeable deformity. This eye is called the *deviating eye*. The one which is normally directed is the *fixing eye*. The symptom of deform-

ity may, however, prove misleading. The direction an eye is looking is judged by the direction the cornea is turned. In some eyes the visual axis pierces the cornea so far from its center that the eye appears to deviate when in reality it is properly directed; and such an eye might really deviate when it appeared straight.

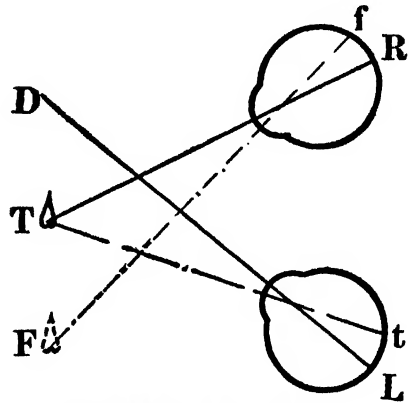
The lack of correspondence between the eyes prevents true binocular vision, if that function has already been developed; or prevents its development. If the patient has previously possessed normal binocular vision the deviation causes diplopia or double vision. This diplopia is distinguished from monocular diplopia by the fact that the covering of either eye removes it.

The image seen by the fixing eye is called the "true image," it being referred to the true position of the object. The image seen by the deviating eye is called the "false image," it being referred, in the consciousness of the patient, to a direction different from the real direction of the object. The relation of this diplopia to the deviation of the eye may be understood from the illustration here given. The visual axis $R-T$ is properly directed toward T , the object looked at; but the other visual axis $L-D$ deviates toward D . In the eye L , therefore, the image of T falls at t , on the nasal or inner portion of the retina; and it is referred or projected in the direction $f-F$ as another object at F , the point f in the fixing eye corresponding to the point t in the deviating eye.

The direction of the false image is always the opposite of the direction in which the eye deviates. Thus, when the eye deviates upward the false image appears below. When the eyes are crossed we have *homonymous*

diplopia; and, when the eyes diverge, *crossed diplopia*.

Diplopia disappears when the strabismus is corrected, or when one eye is closed. It may also disappear through extreme deviation, causing the image in the deviating eye to fall on the extreme periphery of the retina, which is comparatively insensitive. Or it may disappear from habitually disregarding the false image, especially in early life. While, therefore, the presence of binocular diplopia proves



Strabismus. (Edward Jackson.)

the presence of strabismus, its absence does not prove that the eyes are properly directed.

ETIOLOGY.—The normal directing of the eyes depends on an extremely delicate system of reflex actions, which requires sufficiently good vision in both eyes and a central co-ordinating mechanism. The power of accurately co-ordinating the eye movements normally develops after birth. Arrest in its development may cause strabismus. Practical blindness of one eye, especially when it depends on some lesion of the cornea that causes distortion of the retinal images or the diffusion of unfocused light within

the eye, is very likely to cause that eye to deviate.

Errors of refraction are a common cause of strabismus. Hyperopia of rather high degree, 2 D. or upward, compels excessive effort of accommodation, and so brings about excessive convergence. Myopia of very high degree, 10 D. or more, is attended with elongation of the eyeball that makes it difficult to turn it in its socket. This leads to divergent squint through giving up of the effort to turn the eyes in, so strongly as would be necessary to fix both eyes upon an object so close to them. Difference of refraction between the two eyes, making it difficult or impossible for both to focus the object at the same time, also causes strabismus. Paralysis of one or more of the muscles that turn the eye disables it for certain movements and so causes strabismus. More rarely spasm of one or more of these muscles is the cause of a deviation.

Strabismus from lack of development of the co-ordinating mechanism, hyperopia, or difference of refraction between the two eyes develops in early childhood, when it is also most likely to arise from practical blindness of one eye. From myopia it occurs a few years later, as the myopia usually develops during the period of school-life. From paralysis of the third, fourth or sixth nerves, or ocular muscles, it may develop at any time of life. Syphilis and rheumatism are the most common causes of these palsies. But acute infectious diseases, especially diphtheria, injuries, and chronic diseases—as diabetes and Bright's disease—also cause them. Spasm of the muscles is apt to be hysterical.

VARIETIES.—When strabismus is due to paralysis of certain muscles,

causing inability to move the eye in certain directions, it is called *paralytic*. Where the squint is due, not to inability to move the eye, but to a false co-ordination of the movements, so that while the two eyes move freely in all directions they still keep their false relation to each other (as always too convergent or too divergent or one turned too high for the other) the condition is called *concomitant* or *comitant strabismus*.

When the eyes converge too much it is *internal* or *convergent strabismus*. When they diverge, or do not converge enough for near seeing, it is *external* or *divergent strabismus*. When one eye turns higher than the other it is *vertical strabismus*. When it is always the same eye that deviates it is *monocular* or *monolateral strabismus*. When it is sometimes one eye, sometimes the other, that deviates, it is *alternating strabismus*. When a comitant deviation is always present, it is called *constant*, although it may vary much in degree; if sometimes absent it is called *intermittent* or *periodic*.

Paralytic strabismus only appears when the affected muscles are called on to perform their function. It is divided into varieties corresponding to the muscles affected, and usually spoken of as paralyzes of those muscles; as paralysis of the internal rectus, paralysis of the interior oblique. Paralysis of all the muscles supplied by a certain nerve-trunk may also be designated, according to the nerve affected, as *abducens paralysis*, *oculomotor paralysis*, *fourth-nerve paralysis*. Paralysis of all the extraocular muscles, *ophthalmoplegia externa*, causes some kind of squint whenever an attempt is made to look out of the direction in which the affected eye is

turned. If both eyes are affected the strabismus is usually constant.

Latent strabismus, also called *heterophoria*, *muscular insufficiency*, or *imbalance*, or *dynamic squint*, is that condition in which a tendency to strabismus exists, but is overcome by a special effort of the appropriate muscles, in order to avoid diplopia and preserve binocular vision. The insufficiency may be of any one or more of the muscles, shown only or chiefly when the particular muscle is called into action: a sort of latent paralytic strabismus. Or it may be found to be about the same, whatever the direction in which the eyes are turned, a latent comitant strabismus. To the latter variety the term *heterophoria* (from the Greek *ἕτερος*, different and *φωρός*, tending) may be applied. The varieties of heterophoria are *eso-phoria*, tending inward, latent convergent strabismus; *exo-phoria*, tending outward, latent divergent strabismus; and *hyperphoria*, tending upward, or latent vertical strabismus. The latter may be right or left according to the eye which tends to turn above its fellow. *Orthophoria*, right tending, or muscular balance, is the normal condition, the absence of heterophoria.

DIAGNOSIS.—In a case of *apparent strabismus* we must first determine whether the apparent deviation is real. This is done by having the patient fix his gaze steadily upon some distant object; and then, while watching his eyes, covering first one and then the other, so that he is compelled to fix with them alternately. He will fix with the uncovered eye. Then on shifting the cover, if the other eye was also properly directed while it was covered, no movement will occur. But if the covered eye was deviating, it

will have to move in order to fix the point looked at, and the eye which previously fixed will deviate; and these movements will be repeated every time the cover is shifted. The extent of such movements indicates the amount of the deviation, and the direction shows the variety of strabismus.

The *degree of lateral squint* may be measured along the lower lid in millimeters of change in the direction of the eye from the deviating to the fixing position. But it is more accurately measured by the angle of deviation. This may be ascertained by placing the deviating eye at the center of the arc of a perimeter, and directing the gaze toward a distant point in the axis of that arc. Then finding the point of the arc toward which the deviating eye is turned, we read off the angle of deviation. The point toward which the deviating eye is turned is ascertained by moving a candle-flame along the arc, until the surgeon's eye behind the flame sees its reflection in the center of the pupil of the deviating eye. Priestley Smith's method is applicable without a perimeter. In it the surgeon reflects light on the deviating eye with a mirror held at his own eye one meter from the patient, and has the patient look at his finger, which is moved at a distance of one meter from the deviating eye until the corneal reflex from that eye appears at the center of the pupil. The distance from the surgeon's eye to his finger is then the measure of the strabismus. It may be measured on a scale of tangents showing the degrees of squint, or each centimeter corresponds to about one centrad or four-sevenths of a degree. When there is diplopia the amount of squint may also be measured by the distance of the false image

from the true image, or the strength of the prism required to bring them together.

To discriminate between *paralytic and comitant strabismus*, we must note if the deviation of the squinting eye or the separation of the true and false images is confined to a part of the field of fixation, or is greater in some parts than in others. To ascertain which muscle or muscles are paralyzed, note the direction in which the eyes must be turned in order to produce the greatest deviation, or widest separation of the two images, this being the direction in which the paralyzed muscle is most needed to turn the eye. The false image, belonging to the eye which cannot be normally turned, always appears farthest in the direction the eyes are turned. Thus, on looking up, the false image appears higher than the true image; on looking to the right the false image appears the farther to the right. By alternately covering the eyes we can find to which eye the false image belongs, and so the exact muscle or muscles affected.

Diplopia is the rule in paralytic strabismus, unless one eye be blind or covered by a drooping lid; but it is the exception in comitant strabismus.

To recognize latent squint we must interrupt binocular vision. To secure binocular vision the strabismus is rendered latent, and when the effort necessary to prevent strabismus no longer secures binocular vision, it is given up, and the eyes are allowed to deviate. Binocular vision is prevented by covering one eye. When this is done the covered eye deviates. But on removing the covering the eye quickly turns to the position of true fixation. The deviation of the eye under cover may be so slow as to be with difficulty

noticeable; but the quick "recovery" when the cover is removed is very apparent.

By shifting the cover quickly from one eye to the other the eyes may be made to deviate and "recover" alternately. By so shifting the cover back and forth while the patient gazes at a distant lamp-flame, he will see the lamp-flame appear to jump back and forth from one position to another as the cover is shifted. The direction in which the eyes deviate and "recover" and the direction in which the flame appears to jump will tell the variety of latent strabismus present.

Binocular vision may be prevented by making the image received in one eye so unlike the other that there will be little or no tendency to fuse them. This may be done by placing before one eye a dark-blue or purple glass. On looking at a distant flame the patient then sees two: one of the natural color, the other blue or pink. In orthophoria these appear superimposed; but with heterophoria they appear separated. The direction in which they are removed from one another indicates the kind and the distance the amount of latent strabismus.

Binocular vision may also be prevented by use of a prism which so displaces the image formed in one eye that it cannot be fused with the image formed in the other eye. Thus, in the "Graefe test" a prism of 8 or 10 centrads is held with its base up before one eye, and the gaze fixed upon a dot in the center of a blank card. To the eye before which the prism is held the dot appears displaced downward. In orthophoria it appears directly below the true image. In esophoria the lower dot appears below and toward the side of the eye that

sees through the prism; in exophoria downward and toward the opposite side. The phorometers of Stevens and others are mostly based on this principle.

The *Maddox rod-test* is really one in which one image is so distorted as to prevent its fusion with that of the other eye. A very strong cylinder, either a piece of a small glass rod or a concave cylinder of similar strength, is placed before one eye. Seen through this, a point of light appears as a long streak. The other eye being left uncovered, the streak appears in orthophoria to pass through the point of light. But in *heterophoria* the streak appears to pass to one side of the point of light. The side on which it appears to pass indicates the variety of latent squint, and the distance of the streak from the light, or the strength of prism required to cause it to pass through the light, shows the amount or degree of the tendency to deviation.

The method of measuring the amount of strabismus by prisms is applicable in all cases of manifest or latent squint in which the patient can recognize binocular diplopia. It consists in placing before the eyes such prisms as will cause the true and false images to coincide in spite of the strabismus. Such prisms will substitute binocular vision for diplopia; and will do away with all movements of deviation and recovery, or of apparent movement of the point of light looked at, when the cover is shifted from one eye to the other in rapid alternation.

PROGNOSIS.—For apparent squint due to displacement of the cornea, we can do nothing except at the cost of binocular vision. Comitant strabismus is outgrown in a few cases in early childhood without

treatment; and in a much larger percentage of cases may be permanently cured by the wearing of glasses, and proper orthoptic exercises. Comitant strabismus in adults, if intermittent, may be cured by correcting lenses; but if constant will generally require an operation. All cases of comitant squint are capable of relative cure by operations judiciously chosen and skillfully performed, except such as suffer from diplopia when the image is thrown on the fovea of the deviating eye. The exactness and permanence of the cure depend on the possibility of establishing true binocular vision.

Paralytic strabismus may be cured by cure of the paralysis causing it. If the paralysis be well marked, recovery will probably require at least six weeks. Complete paralysis that has lasted many months without decided improvement is likely to be permanent. After incomplete recovery from paralysis of one of the eye-muscles, operative treatment may give practical relief. Strabismus due to a permanent complete paralysis cannot be cured; but may be made less noticeable or troublesome by prisms or appropriate operations. The diplopia of comitant strabismus usually ceases to be annoying or disappears entirely. Diplopia from paralytic squint, except when it has occurred in childhood, will commonly last throughout life.

TREATMENT.—In every case of strabismus, any obstacle to easy binocular vision, in the form of an error of refraction, should be removed by the constant wearing of **correcting lenses**. All eye-work or habits tending to cause or perpetuate the strabismus should be discon-

tinued. If due to an ocular palsy this should be treated. If of recent origin, **orthoptic exercises** should be resorted to. If the strabismus be constant and of long standing, and not much influenced by the wearing of correcting lenses, and if throwing the image on the fovea of the deviating eye when the fixing eye is also in use does not cause diplopia, an **operation** should be done.

Correction of any error of refraction is the first step. It may be done at a very early age. Children 2 years old can have their correcting lenses determined by skiascopy and will readily and gladly wear them, if they are much needed and accurately adjusted. The avoidance of injurious use of the eyes may require the use of a mydriatic to suspend all effort of accommodation. Or it may include, for monolateral strabismus, the covering of the fixing eye, or the placing of it alone under the influence of a mydriatic, to compel the patient to use the eye he would otherwise allow to deviate.

Orthoptic exercises include: the viewing of special diagrams and pictures through the stereoscope; the exercise of muscles that are relatively inefficient by placing prisms so that they will bring the true and false images close enough together for the muscles to complete their fusion, in actual squint, or so that the prism will require special exertion to "overcome" it in latent squint. They also include the use of "fusion tubes," which are applied one to each eye and turned so that the eyes can just fuse the minute openings in the distal ends of the tubes. Also the employment of the "reading-bar," an opaque bar supported above the page

in such a way that it cuts off a portion of each line from one eye, and another portion from the other eye, compelling fixation with both eyes for the reading of each line. The diploscope of Remy and diaphragm test of Harman allow letters to be seen through an opening. By varying the distance, position or size of the openings, they can be used for orthoptic training. Under this head also comes the practice of exercising convergence, by fixing on a point that is gradually made to approach the eye until the requirement of convergence becomes too great to be sustained. Or the practice of viewing through strong prisms, turned with the base toward the nose, a point which starts near the eyes, but is slowly withdrawn until the limit of the power of abducting the eyes is reached.

Operations on the ocular muscles are of three kinds: tenotomy, designed to lessen the influence of an overacting muscle; advancement, designed to increase the influence of a muscle relatively weak or inefficient; and lateral displacement which may cause one muscle to perform the function of another muscle that is congenitally defective or paralyzed. Tenotomy is the simplest and least formidable operation. But it tends to lessen the total mobility of the eye, and if injudiciously performed may cause the eye to deviate in the opposite direction. Advancement is a more difficult and serious undertaking, but it does not lessen the mobility of the eye, and is not likely to cause a strabismus of the opposite kind. Lateral displacement of the insertion of the tendon of a rectus muscle is to be planned to meet the

indications of the particular case, after careful consideration of all the movements that will be influenced by it.

For **tenotomy** the eye is cocaineized and the conjunctiva seized over the insertion of the muscle to be operated upon, and incised with a snip of the scissors. The incision may be small—4 or 5 millimeters (subconjunctival method)—or large—8 or 10 millimeters (open method). The subconjunctival tissue is then similarly raised and snipped through, down to the sclera. A strabismus-hook is now introduced beneath the tendon, and made to lift it from the sclera. One blade of fine, but blunt-pointed, scissors is then slipped beneath the tendon close to its insertion, and the tendon is divided at this point by the scissors.

For a **partial tenotomy** a small conjunctival incision is made over the center of the tendon at its insertion, after which the tendon itself is caught up with the forceps and snipped through. Then, through the small central opening so made, a small strabismus-hook is introduced and the tendon divided on either side, until only a thin margin remains, which can be readily stretched with the hook. The subsequent stretching of these margins permits a slight retraction of the whole tendon. Partial tenotomy is also done by dividing a part of the width of the tendon at its insertion, and the remainder of the fibers farther back, making two or three cuts that each divide only a portion of the fibers of the tendon, but together divide all of the fibers.

To increase the effect of a tenotomy by permitting a greater retraction of the divided tendon, its lateral connections may be divided

and the tendon thus isolated from all its attachments that indirectly connect it with the eyeball. **Extended tenotomy** divides, not only all the fibers of one rectus, but also the adjoining fibers of the recti on either side of it. Thus, for convergent strabismus after dividing the tendon of the internal rectus, the nasal half or three-fourths of the tendons of the superior rectus and inferior rectus may be divided, when these still hold the eye in a position of excessive convergence. In this way the effect of a tenotomy may be more than doubled. Another measure is to keep the eye forcibly rotated away from the tenotomized muscle by what is called the **thread-operation**. In this a suture is inserted near the divided muscular insertion and made fast over a roll of adhesive plaster so as to keep the eye in position for the divided tendon to slip as far back as possible.

Advancement of the ocular muscles is done in several different ways. The natural insertions of the recti tendons are from 5 to 9 millimeters back from the margin of the cornea. The common operation is done through a free incision parallel to the corneal margin. The tendon is isolated, raised from the globe, its insertion divided, and brought forward to or near the corneal margin, where it is fixed by sutures. The sutures may be passed through firm scleral tissue or may only include conjunctiva and subconjunctival tissue, one passing above and another below the cornea. The former give the more certain and definite attachment, but the latter are easier to insert. When a marked deviation is to be corrected, advancement of one

muscle is accompanied by tenotomy of its direct antagonist. Sometimes a portion of the advanced tendon is cut off (muscle-shortening). Sometimes the tendon is not divided at its insertion, but is folded upon itself, and so shortened (tendon-tucking). Some operators do not attempt to isolate the tendon, but pass sutures through the conjunction and the capsule of Tenon. This is spoken of as **capsular advancement**.

After-treatment.—After tenotomy it is usually best not to bandage the eye, or only for a day or two. After advancement some operators keep both eyes bandaged for a week or more. Generally the eyes should be brought into use together as soon as practicable, and correcting lenses worn constantly, and such use made of the eyes, or such orthoptic exercises resorted to, as will favor the perfecting of binocular movements and binocular vision.

Prisms, aside from their use as means of securing orthoptic exercise and training, are of value in relieving some of the consequences of strabismus. In actual lateral squint they are scarcely applicable, because the squint is usually of such high degree that the necessary prism would be too thick and heavy to wear. But for vertical strabismus, or for latent squint, they are often of great practical service. The apex, or thin part, of the prism is turned in the direction in which the eye turns or tends to turn. Thus, for right hyperphoria the prism for the right eye would be turned with its edge up, its base down. Turned in this way the prism does not "correct," but rather "permits" the deviation. But the prism removes the unpleasant effects of

such a deviation, such as diplopia, or the strain of the ocular muscles necessary to preserve parallelism of the visual axes. Prisms may be valuable aids in establishing binocular vision after an operation on the eye-muscles or during recovery from paralysis of one or more of the ocular muscles.

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STRAMONIUM.—Stramonium, U. S. P. (Thorn-, Devil's-, or Mad- apple, Stink-weed, Jamestown or Jimson weed, or lily, Devil's trumpet) is the dried leaves of *Datura stramonium* (fam., Solanaceæ), containing not less than 0.25 per cent. of mydriatic alkaloids. The plant, native in Asia, is exceedingly common and abundant in the United States, in rich ground, about barn-yards, lumber-yards, and other waste places. The leaves should be gathered when the plant is in full bloom and dried carefully in the shade. The plant is an annual, with green stem, coarse, rank-smelling leaves, and large, bell-shaped, white or purple flowers. When the seeds are eaten by children poisoning occurs, sometimes with fatal results. Poisoning has also occurred through drinking an infusion of the leaves. Its alkaloid, formerly called "daturnine," is now known to be identical with other solanaceous alkaloids, hyoscyamine, or atropine, or a mixture of the two, chiefly hyoscyamine. A little hyoscyne is also probably present. The alkaloid occurs as colorless needles, soluble in alcohol, ether, and chloroform. The hydrochloride and sulphate occur as white crystals, soluble in water and in alcohol. All the preparations are now made from the leaves.

PREPARATIONS AND DOSES.—

Stramonium, U. S. P. (leaves; folia '90)
Dose, 1 to 3 grains (0.06 to 0.2 Gm.).

Extractum stramonii, U. S. P. (solid extract). Dose, $\frac{1}{4}$ to $\frac{1}{4}$ grain (0.008 to 0.016 Gm.).

Fluidextractum stramonii, N. F. (fluid-extract). Dose, 1 to 3 minims (0.06 to 0.2 c.c.).

Tinctura stramonii, U. S. P. (tincture,

10 per cent. of leaves, or 0.025 per cent. alkaloids). Dose, 10 to 30 minims (0.6 to 2 c.c.).

Unguentum stramonii, U. S. P. (ointment, 10 per cent. of extract).

PHYSIOLOGICAL ACTION.—The physiological action of stramonium and its alkaloids is almost identical with that of belladonna and atropine. Specimens containing a small quantity of hyoscyne are slightly more sedative to the central nervous system. In poisonous doses they produce the same symptoms and require the same treatment. (See *BELLADONNA*.)

THERAPEUTIC USES.—Stramonium is a favorite remedy in **spasmodic asthma**; it is used by smoking the dried leaves in a pipe or cigarette, either alone or mixed with cubeb, sage, and other drugs, or inhaling the fumes of the burning leaves or ignited powder. A very good mixture for igniting and inhaling is one of 3 parts of potassium nitrate, 1½ parts of potassium chlorate, 3 parts of broken, or powdered, stramonium leaves, and 1 part of ipecac; moisture may be added if cones are desired, which latter must be dried before ignition.

The ointment is used to relieve the pain of **muscular rheumatism, neuralgia, and hemorrhoids** and **fissure**. In the latter the ointment will relieve both the pain and tenesmus. The ointment is a mild anodyne application in **itching and burning affections of the skin**. The alkaloid may be substituted for atropine as a **mydriatic**.
W.

STRONTIUM.—Strontium is an alkali metal having a yellow color. Like the other alkali metals, it oxidizes quickly on exposure to the air, and must be kept under naphtha, benzene, or other liquid free from oxygen. Strontium forms salts with the acids and with bromine, chlorine, fluorine, etc.

PREPARATIONS AND DOSE.—Three salts are official:—

Strontii bromidum, U. S. P. (strontium bromide) $[\text{SrBr}_2]$, occurring in hexagonal, colorless crystals, very deliquescent, and having a bitter, saline taste. It is freely soluble in water and in alcohol. Dose, 10 to 30 grains (0.6 to 2 Gm.); average, 15 grains (1 Gm.).

Strontii iodidum, U. S. P. (strontium iodide) $[\text{SrI}_2]$, occurring in colorless or faintly yellow hexagonal plates, having a bitter, saline taste. It is freely soluble in water and in alcohol. Dose, 5 to 30 grains (0.3 to 2 Gm.); average, 7½ grains (0.5 Gm.).

Strontii salicylas, U. S. P. (strontium salicylate) $[(\text{C}_6\text{H}_4\text{OH}.\text{COO})_2\text{Sr}]$, occurring as a white, crystalline powder soluble in 18 parts of water and in 66 parts of alcohol. Dose, 5 to 30 grains (0.3 to 2 Gm.); average, 10 grains (0.6 Gm.).

Among the unofficial salts of strontium more or less frequently used are:—

Strontium lactate $[(\text{C}_3\text{H}_5\text{O}_2.\text{CHOH}.\text{COO})_2\text{Sr}]$, occurring as a white, granular powder, with a slightly bitter taste, soluble in alcohol, in 4 parts of cold and in 0.5 part of boiling water. Dose, 10 to 40 grains (0.6 to 2.5 Gm.).

Strontium nitrate $[\text{Sr}(\text{NO}_3)_2]$, occurring in colorless crystals, soluble in 1.4 parts of water and slowly in alcohol. Dose, 5 to 15 grains (0.3 to 1 Gm.).

Strontium peroxide, occurring as a mixture of true strontium peroxide $[\text{SrO}_2]$ and a small proportion of strontium hydroxide $[\text{Sr}(\text{OH})_2]$. It occurs as a fine, white, tasteless powder which, on contact with water, is gradually decomposed into hydrogen peroxide and strontium hydroxide, the former being further decomposed by the latter with liberation of oxygen. Dilute acids decompose it to form a solution of hydrogen peroxide. Used externally as a dusting powder and in ointments.

PHYSIOLOGICAL ACTION.—The strontium salts do not, in ordinary amounts, produce any distinct effect upon the human system. In animal experiments, enormous amounts of strontium salts, continuously given, cause inflammation of the gastrointestinal mucosa. According to some clinical observers, strontium salts in therapeutic dosage tend to improve general body nutrition. If this is true, the effect may be due to the production of a mild active hyperemia in the intestine, favoring proper absorption and assimilation. H. C. Wood saw reason for believing that strontium acts as a feeble antiseptic in the alimentary canal and acts

favorably on the digestive glands and muscles, thereby improving digestion.

The dominant action of the strontium salts, however, is usually that of the acid radicle with which the strontium is combined. Thus, strontium bromide acts as a nervous sedative; the iodide, as an alterative, and the salicylate, as an analgesic and antirheumatic. Strontium lactate, on the other hand, has been used chiefly for strontium effects, and has been held to improve the coagulability of the blood and to diminish albumin excretion in some forms of nephritis. According to Laborde, strontium lactate and tartrate possess diuretic properties.

Absorption of strontium into the system from its salts is moderately rapid. According to Wood and Arnold (1899), no salt of strontium is absorbed from hypodermic injections. Strontium absorbed after oral administration may be deposited in the body, chiefly in the bones. According to L. B. Mendel and H. C. Thacher (1904), strontium salts are eliminated only in small part by the kidneys. The larger portion eliminated is found in the feces, whether the drug has been given by mouth, subcutaneously, or intravenously.

THERAPEUTICS.—Strontium salts have for many years had the reputation of being less irritant to the alimentary tract than the corresponding salts of sodium, potassium, or other alkali metals, and have, therefore, often been substituted for the latter salts, either from the beginning of treatment or after irritative symptoms from other salts have supervened. According to Hare, strontium salicylate, for example, taken in capsules or cachets followed by a draught of milk or water, is far less apt to upset the stomach than salicylic acid itself, or the other salicylates. Blankenhorn (1916), however, administering the drug in 20-grain (1.3 Gm.) hourly doses (with an equal amount of sodium bicarbonate) in 22 cases of acute rheumatism, endocarditis, etc., found the average total amount required to induce nausea, with or without other signs indicating salicylism, to be 180 grains (12 Gm.)—the same amount as had been determined by Hanzlik in previous research with sodium salicylate under like condi-

tions. Nevertheless, the impression is widely prevalent that strontium salts are less irritant than others, and clinical evidence advanced to the contrary has not so far been sufficient to disprove this.

Acute Rheumatism and Constitutional Disorders.—Strontium salicylate may be given with good results in *rheumatic fever*, in *subacute rheumatism*, and in *chronic gouty* manifestations accompanied with digestive disturbances.

Strontium iodide has likewise been found of value in *subacute, chronic, and muscular rheumatism*, in *subacute or chronic gout*, and in *rheumatic sciatica* and *trifacial neuralgia*. It has been used to good advantage in certain local manifestations of tuberculosis, such as *tuberculous adenitis*, *tuberculosis cutis*, *tuberculous disease of the bones and joints*, and in *scrofulous otorrhea*, *ozena*, and *ophthalmia*. It contains about 56½ per cent. of iodine, and may be substituted for potassium iodide, often with advantage, in the various conditions indicating the use of iodides.

Strontium lactate has been given, in *rheumatism* and *gout*, in doses of 20 or 30 grains (1.3 or 2 Gm.) in solution, to exert a favorable influence upon the alimentary tract.

In *diabetes mellitus* the bromide and salicylate of strontium have been observed to cause a distinct diminution of sugar excretion.

Lehnerdt (1911) found that administration of strontium phosphate in large quantities to young animals, especially where calcium is excluded from the diet, imparts a formative stimulus to the bones, giving rise to spongy osteoid formations at the ends of the bones and excess of callus in cases of fracture. He suggests the use of strontium salts in *osteomalacia*, conditions associated with *osteoporosis*, and in *delayed union* or *callus formation*.

Nias states that the lactates of strontium and magnesium, in doses of from 1 to 2 Gm. (15 to 30 grains), are serviceable substitutes to improve the *coagulability of blood*, for the salts of calcium when the latter are not absorbed from the alimentary canal.

Nephritis.—Strontium lactate was observed by Germain Sée, Constantin Paul,

Dujardin-Beaumetz, and others to exert frequently a controlling action on albuminuria in chronic nephritis, especially the parenchymatous form. The drug has also at times proven useful in the albuminuria of pregnancy. The modus operandi is not clear. Occasionally a simultaneous diuretic action is noticed. Paul gave the drug in a daily dosage of 2 drams (8 Gm.) for as long as two months without untoward effects.

Cardiovascular Disorders.—Strontium iodide may be substituted for potassium iodide in such conditions as aortic aneurism, arteriosclerosis, and angina pectoris, proving useful, especially where the potassium salt is not well borne. According to a widely held view it can be safely given in comparatively large doses, being much less apt to bring on symptoms of intolerance.

Gastrointestinal Disorders.—Strontium bromide has been used with benefit in gastralgia, nervous vomiting, and vomiting of pregnancy. A. B. Briggs used it with success in 10-grain (0.6 Gm.) doses 1½ hour before meals in gastric hyperesthesia. Caselli used it to allay vomiting and pain in acute gastritis.

Strontium salicylate, given in capsules in doses of 5 or 10 grains (0.3 or 0.6 Gm.) after meals, has been used with asserted benefit as an antiseptic in abnormal gastric or intestinal fermentation with flatulence. Strontium lactate has likewise been employed to inhibit fermentation and aid digestion in gastric cases with hyper- or hypo-chlorhydria, and in chronic intestinal catarrh.

Nervous Disorders.—In epilepsy, strontium bromide may be used with satisfactory results in doses of from 40 to 80 grains (2.5 to 5 Gm.) a day. It is considered less likely, in large doses, to produce gastric disturbance, skin eruptions, etc., than the other bromides. Some, however, consider it less effectual than the customary salts, and use it merely in combination with them as adjuvant. The drug has also been employed for its sedative action in hystero-epilepsy and exophthalmic goiter.

Cutaneous Disorders.—Strontium iodide may be substituted for the potassium salt in psoriasis or eczema, when associated

with a rheumatic taint, in erythema multiforme or nodosum, in purpura rheumatica, and in lupus vulgaris and other tuberculous skin affections. It may also be used in the skin manifestations of tertiary syphilis. In senile pruritus strontium bromide has been observed to procure relief. S.

STROPHANTHUS.—Strophanthus (U. S. P.) is the seed of *Strophanthus kombé*, deprived of its long awn. The plant itself is a climbing, pod-bearing shrub of the family Apocynaceæ, and grows in tropical Africa. The seeds contain 1 to 3 per cent. of an intensely bitter, crystalline principle called *strophanthin*, which is a glucoside, freely soluble in water. This substance is recognized in the U. S. P. as a crystalline powder, but occurs also in amorphous form. It is obtained not only from *S. kombé*, but also from *S. hispidus*. Ouabain, or gratus strophanthin, is a related unofficial principle obtained from *S. gratus*.

PREPARATIONS AND DOSE.

—*Strophanthus*, U. S. P. (strophanthus), the seed of *S. kombé*. Dose, 1 grain (0.06 Gm.).

Tinctura strophanthi, U. S. P. (tincture of strophanthus), a 10 per cent. preparation. Dose, 8 minims (0.05 c.c.).

Strophanthinum, U. S. P. (strophanthin) [$C_{31}H_{48}O_{12}$], occurring as a yellowish-white, crystalline powder, very soluble in water and in dilute alcohol, less soluble in alcohol, and insoluble in ether or chloroform. Dose, $\frac{1}{200}$ to $\frac{1}{65}$ grain (0.0003 to 0.001 Gm.).

Ouabain (crystalline ouabain, *Gratus strophanthin*, "crystalline strophanthin," *G. strophanthin*, Thoms) [$C_{30}H_{46}O_{12} + 9H_2O$], unofficial, occurring in colorless, quadratic crystals

of bitter taste, soluble in 100 parts of cold water, easily soluble in hot water, soluble in 30 parts of alcohol, slightly soluble in ether and in chloroform. Dose, $\frac{1}{200}$ to $\frac{1}{65}$ grain (0.00025 to 0.001 Gm.).

PHYSIOLOGICAL ACTION.—

The characteristic effects of strophanthus are exerted upon the circulation, and are in most respects identical with those of digitalis. The heart muscle is strongly excited and toned up, the rate of heart action is slowed through central as well as peripheral vagus stimulation, and the output of the organ is augmented owing to the more complete filling of the left ventricle during diastole and emptying during systole. In the hypodynamic heart the force of contraction of both auricles and ventricles is greatly increased (A. J. Clark). As with digitalis, large doses of strophanthus tend to impair conduction of the contractile impulse from auricles to ventricles. For additional details as to the action of strophanthus on the heart the reader is referred to the article on DIGITALIS.

Though a vasoconstrictor, like digitalis, strophanthus acts less strongly in this respect than the latter drug. Neither remedy, as a matter of fact, exerts in ordinary therapeutic doses a vasoconstrictor effect sufficient to induce a general rise in blood-pressure. Of greater significance is the difference in susceptibility of the vessels in different organs to the drugs. Thus, experimentally it has been determined that, with a certain dose of strophanthus, the renal vessels can be dilated while the extensive mesenteric vascular system is simultaneously constricted—a condition clearly favoring diuresis, which, as in the case of

digitalis, is a characteristic therapeutic effect of the remedy in patients with cardiac edema. Strophanthus is held to be less likely than digitalis to constrict the coronary vessels of the heart in full doses; this has been suggested as an advantage of the drug over digitalis in certain cases.

A salient difference between strophanthus and digitalis is that relative to rapidity of action, the former being far more speedily absorbed from the alimentary tract. The effect of strophanthus in reducing the pulse rate appears in half an hour, and upon interrupting its administration its action disappears more quickly than with digitalis. The action of the drug when taken by mouth is, however, distinctly less certain than that of digitalis—a difference ascribed in part to greater susceptibility of the contained strophanthin to impairment by the digestive juices than in the case of the digitalis glucosides.

Union of absorbed strophanthin with the heart tissues is believed to be much looser than that of the digitalis principles. Elimination of the drug through the kidneys is more rapid, and cumulative effects are much less likely to occur.

Strophanthin has been shown to be a direct stimulant of intestinal muscle (Bastedo), and the drug is by some believed to be more active in causing diarrhea than digitalis. It also possesses local anesthetic properties and acts as a mydriatic when applied to the cornea.

In animal experiments strophanthus proves more toxic to the heart than digitalis, producing cardiac arrest in doses many times smaller than does digitalis. Clinically this difference is greatly reduced owing to

the less perfect absorption of strophanthus. A given dose of tincture of strophanthus remains, however, about twice the equivalent of an equal amount of tincture of digitalis.

UNTOWARD EFFECTS AND

POISONING.—The untoward effects of strophanthus are the same as with DIGITALIS (*q. v.*), consisting chiefly of nausea and vomiting, diarrhea, signs of renal irritation, and changes in the rhythm of the heart. Poisoning by massive doses, except in experimental work in animals, is rare, and is characterized by excessive vagus action and cardiac oppression, sometimes followed by excessive cardiac irritability and increased heart rate, prostration, dyspnea, and death by combined circulatory arrest and respiratory failure. Corin (1908) has shown that poisonous amounts of strophanthus cause an extreme constriction of the pulmonary blood-vessels.

The treatment of poisoning by massive doses of strophanthus consists chiefly in the use of **emetics**, **gastric lavage** through a **stomach-tube**, the application of a **mustard plaster** to the **precordium**, the administration of **atropine** to block cardiac inhibition, and, if necessary, the use of **stimulants**, **external heat**, and **artificial respiration**.

THERAPEUTICS.—The indications for the use of strophanthus are much the same as those for digitalis. It is conceded, however, that the effect of strophanthus is less certain and less lasting, though more prompt in onset and less cumulative, than that of the more widely used drug. In cardiac weakness a single full dose of strophanthus will usually produce a fall in the frequency and an increase

in the strength of the pulse in from one-half to one hour, the effects lasting from 4 to 8 hours. The full action of the drug on the heart, upon repeated ingestion, is often developed in 24 to 36 hours. According to some investigators, strophanthus produces less vasoconstriction in the splanchnic (abdominal) area than digitoxin—the chief principle of digitalis. Gottlieb and Magnus have apparently shown that, in contrast to digitoxin, strophanthus produces no constriction of the coronary vessels—an important point where the production of cardiac hypertrophy is desired (Hatcher).

Tincture of strophanthus is approximately given in 10- to 16-drop (about 5 to 8 minim) doses, a medicine dropper being used to measure the amount into water in a tumbler. Where it is desired to order teaspoonful doses, a little glycerin, according to Gordon Sharp, should be added, to prevent precipitation and adhesion of the active principle to the sides or bottom of the bottle, *e. g.*:—

R. Tinctura strophanthi... f3j (4 c.c.).

Glycerini f3ij (8 c.c.).

Aque menthae piperita,

q. s. ad..... f3iss (48 c.c.).

M. Sig.: One teaspoonful three or four times a day.

An extract of strophanthus (1 in 2) is sometimes useful in doses of $\frac{1}{4}$ to 1 grain (0.015 to 0.06 Gm.) in pill form where the tincture is rejected; it acts less rapidly but more persistently than the tincture.

Strophanthus will not in all cases prove as beneficial clinically as digitalis, but where digitalis has failed, or has had to be discontinued for any reason, it has often shown itself a valuable substitute. Wadleigh recom-

mends strophanthus especially in **cardiac weakness in aged people**, in the **vertigo** of the aged due to cerebral anemia or poor circulatory balance, in **angina pectoris**, in **anemia** in general, or **chlorosis**, when accompanied by cardiac weakness, and in the "**irritable heart**," palpitating on slight exertion, with precordial pain, weak, rapid pulse, but no organic cardiac disease.

Strophanthus has been credited, perhaps wrongly, with diuretic properties greater than those of digitalis, the drug being advised in preference to the latter in pronounced **anasarca** and **pulmonary edema** the result of cardiac disease. In renal affections with secondary failure of the heart, it is also a valuable remedy.

According to Sharp (1913) strophanthus has an analgesic action on vital nerve centers, and is therefore of particular value in the **breathlessness** and general distress experienced in many forms of **heart disease**. In such conditions it must be given in maximum doses and repeated every 2 hours till relief is obtained.

In **exophthalmic goiter**, especially with cardiac enfeeblement, strophanthus has been highly recommended. Ferguson advises its use in this condition in doses of 8 minims (0.5 c.c.) of the tincture at first, later gradually increased.

Because of its more prompt action strophanthus has often been substituted for digitalis in cases of **acute heart-failure**, of whatever origin. As emphasized, however, by Hatcher, absorption of strophanthus or strophanthin when used orally is rather uncertain. Excretion of the remedy being, moreover, relatively rapid, strophanthin may at times fail to

be present in the circulation in sufficient amount to exert a powerful influence on the heart.

Hatcher considers the official dose of strophanthin, intended for oral use, entirely too small. For these reasons intramuscular and intravenous use of strophanthin has been advised and come into widespread popularity. According to Hatcher and Bailey, 0.0003 to 0.0005 Gm. ($\frac{1}{200}$ to $\frac{1}{120}$ grain) of ouabain (gratus or "crystallized" strophanthin) in sterile (boiled) salt solution may be injected deeply into the gluteal muscle once in 24 hours without fear of abscess formation or other untoward actions. In urgent cases, however, intravenous injection is generally preferred.

Fränkel, after practical experience in numerous cases, highly recommends repeated intravenous strophanthin injections when digitalis is not borne or has lost its effect in **chronic heart disease**. He has given as many as 85 such injections, ranging in dosage from 0.00025 to 0.001 Gm. ($\frac{1}{260}$ to $\frac{1}{65}$ grain) to a single case of **chronic valvular defect** and **myocardial degeneration** within a year and a half, with excellent results. Good effects have also been obtained in the **cardiac insufficiency of chronic nephritis** with contracted kidneys, in the hepatic type of chronic heart disease, and in the **acute heart weakness of infectious diseases** or **acute pericarditis**, and in **pulmonary edema** with low blood-pressure. According to Vaquez and Leconte, strophanthin, in urgent cases, acts best in **primary myocarditis** without valvular lesions. Truelsen holds that the first injection of strophanthin should not exceed 0.5 mg. ($\frac{1}{120}$ grain). The lower initial dose must be employed if the injection follows digitalis medication, and 3 or 4 days be allowed to intervene.

For intravenous injection the official type of strophanthin—amorphous or Boehringer strophanthin—is obtainable as a sterile 1:1000 solution in ampoules each containing 0.001 Gm. ($\frac{1}{65}$ grain) of the active principle. The initial dose is often 0.0005 Gm. ($\frac{1}{130}$ grain), soon increased, if well borne, to 0.00075 and 0.001 Gm. ($\frac{1}{65}$ and $\frac{1}{65}$ grain). The 0.00075-Gm. dose is often sufficient to give brilliant results, dyspnea rapidly subsiding, the pulse becoming fuller, regular, diuresis setting in and sleep promptly following. An increase in amplitude of the pulse (pulse pressure) ranging from 20 to 100 per cent. is the best objective criterion of the satisfactory action of the drug (Williamson). In administering an injection, the patient should be placed on his back, and care should be taken to make sure that the needle is actually in the vein, as the glucose, if it comes in contact with the surrounding tissues, will cause much pain and possibly thrombosis. Before the piston is pushed home it should be withdrawn until a drop or two of blood enters the syringe. The injection should, furthermore, be made slowly, the drug being so toxic to the heart when it reaches it in excessive concentration. In a few cases such injections have been followed by dangerous symptoms and even death, but these untoward results are ascribed by some to the administration of digitalis by mouth shortly before the intravenous strophanthin therapy, sudden intoxication by an excess of digitalis bodies resulting. Care should be taken to allow several days or, better, a week to elapse between oral digitalis treatment—even when ineffective—and intravenous strophanthin medication. Strophanthus, in-

travenously, according to Schleiter, has a decisive effect in all cases of *pulsus irregularis perpetuus*. He also found it beneficial in *paroxysmal tachycardia*.

Gratus strophanthin (ouabain) may be substituted for the official strophanthin. According to most observers the dosage with this product should be slightly smaller than with the other, though according to Johannesohn and Schaechtel (1914) the intravenous dose of crystalline strophanthin (Thoms) may be given intravenously in doses twice as large as the other strophanthin, and is rapidly effective when given by mouth in doses 3 or 4 times as large. Headache, dizziness, nausea, and vomiting have at times followed intravenous injection of either type of strophanthin.

Ouabain used from ampoules containing 0.0005 Gm. ($\frac{1}{130}$ grain) in a 1:4000 solution in sterile saline. The dose injected ranged from 1 to 2 c.c. (16 to 32 minims), intramuscularly or intravenously. Immediate improvement of blood-pressure was noted. Reduction of a tachycardia or restoration of a bradycardia toward the normal rate are favorable indications. In cardiac hypertrophy and dilatation a considerable reduction in the relative cardiac dullness can be expected, but this does not imply a constant therapeutic result. Reduplicated sounds and extrasystoles may disappear, but cardiac murmurs are not liable to change in character. E. Zuehlin (Med. Rec., Aug. 31, 1918).

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STRUMA. See GOITER.

STRYCHNINE. See NUX
VOMICA.

STYE. See EYELIDS DISEASES OF:
HORDEOLUM.

STYPTICIN. See COTARNINE.

STYPTOL. See COTARNINE.

SUBPHRENIC ABSCESS. See LIVER, DISEASES OF.

**SUGGESTION-THERAPY;
PSYCHOTHERAPY; HYPNOTHERAPY (HYPNOTISM).
—PSYCHOTHERAPY.**

A cursory survey of the present status of the question will suffice to afford a general idea of its purpose. First of all, it is necessary to obtain a clear conception of the principles underlying the classification of diseases of the nervous system. Smith E. Jelliffe and William A. White (Jour. Amer. Med. Assoc., Mar. 11, 1916) have recently furnished us a clear summary of these principles:—

"For pragmatic purposes, . . . the nervous system may be divided into . . . three levels of activity: the *vegetative* or physicochemical, the *sensorimotor*, and the *psychic* or symbolic. . . . It is thoroughly well established that lying back of consciousness is a much larger, a much more important territory which furnishes psychic motivation of conduct, and, in fact, that conscious processes as they are known to the individual are largely, if not altogether, determined by what lies in this region—the *unconscious*.

"With the help of the hypothesis of the unconscious, . . . it has come to be recognized that the psyche has its embryology and its comparative anatomy—in short, its history—just as the body has, and in precisely the same way as in the care of the body this history has to be utilized before we can understand it.

"So long as the unconscious failed to be recognized, just so long was the gap between so-called body and so-called mind too wide to be bridged, and so there arose the two concepts, body and mind, which gave origin to the necessity of defining their relations. Consciousness covers over and obscures the inner organs of the psyche, just as the skin hides the inner organs of the body from vision. But just

as a knowledge of the body first became possible by the removal of the skin and the revealing of the structures that lay beneath, so a knowledge of the psychic first became possible when the outer covering of consciousness was penetrated and what lay at greater depth was revealed. As soon as this was done, the wonderful history of the psyche began to give up its secrets, and the distinction between body and mind began to dissolve, until now it has come to be considered that the psyche is the end-result in an orderly series of progressions in which the body has used successively more complex tools to deal with the problems of integration and adjustment."

There exists, in normal persons, a direct, clear, instantaneous intercommunication between that part of the mind which receives impressions and that which is conscious of them. When the communication is normal between the observing, the receptive, reasoning mind and the believing, deliberative or reflective mind, then alone is there right control of thinking, feeling, and doing. When this communication is interrupted or broken, or co-ordination is imperfect, then begins hesitation, doubt, fear, depression, incompetency, or mental anguish. Mental distress or indecision is due not to lack of nervous activity so much as to waste, to prodigality of effort, bad habits, inexact methods. This whirl of ineffective forces being, moreover, exhausting, there arise asthenias or weaknesses. The mind then surrenders and no longer fights; so brain control is vitiated or lost, and we have the condition known as *psychasthenia*.

The psychopathic, neurotic, or the psychasthenic person, then, is one in whom confused feelings, incomplete actions and reactions predominate.

When attempting to pursue an idea the elements of decision are perceived vaguely; frantic efforts are often made, producing exhaustion, ineffectiveness, alarm, and despair. An uncontrolled mind squanders uselessly an enormous amount of force. Force must be conserved; otherwise, disorder or disease in tissue follows. The will is not a fountain of force so much as a toolholder for the lathe, to direct and put the power where and when it will do the most good.

Many ailing persons become so merely because of dwindling in capabilities for reaction to environment and of unawareness of their latent capabilities. They often possess acute perceptions and clear intuitions, which, properly controlled, would place them above the average of efficiency. If their consciousness is allowed to become or remain inert, passive, then will external influences turn aside the force of wholesome decision, mar judgment, induce doubts. Psychasthenics or psychopathics lack confidence because of previous disappointments in determining or carrying out purposes; hence fear grows, blunders multiply, distress or despair follows. Evil temper, sullenness, deceit, selfishness, and all the other invalid uglinesses are the outcome of abnormalities in volitional poise, in deciding what to do and what not to do.

Abnormal fatigability leads to hypersensitiveness to stimuli, induces emotional anomalies, confusing alternations of sensations, vitiations of impressions, elementary hallucinations. It also leads to mental irritability, distractibility, and incapacity to fix or maintain the attention. Hence follow despondencies and hypochondriasis.

Psychasthenia, mental weakness in its varied forms and causation, is often due to lack of correct early training, development, or conservation, and presents a group of puzzling and baffling phenomena. There follows a host of irrepressible impulses, ideas, persistent morbid questionings, apprehensions, diffused emotional disturbances, anomalies of perception or character and action, shown in vacillations, insistent perplexities, religious fears, obsessions, and the like.

How to aid the sufferers?

The great desideratum is to put the patient in the way of realizing exactly the cause of wretchedness, where it may lead, and to set his feet on the right road. This is the aim of psychotherapy. The individual psychotherapist studies the problem, determines, by precise methods and with full knowledge of analogous instances, just what the condition exhibits and requires, and then applies the needful measures. The purpose of psychotherapy, in short, is to reduce a disorderly, inefficient mind to an orderly, well-balanced, efficient one by mental training.

Psychotherapeutic Technique.—

Often enough, all that is needed for conspicuous success in dealing with minor psychoses is the encouraging or explanatory word spoken in season. It is both easy and eminently proper for clergymen to counsel hope, resignation, or faith; for a drug-clerk to administer some well-tried, "simple" remedy; for the foreman in a lumber camp to bind up an axe-cut. Within their limitations, any or all of these render good service, and at least four times out of five the measure is sufficient *when the problem is uncomplicated.*

Such persons become menaces to the community, however, when they branch out and assume the rôle of universal "healers." The extent to which overbold ignoramuses can imperil life and reason reaches its zenith in certain modern health cults, the apostles of which, reckless of truth and denying experience, assume the non-existence of disease as the cornerstone of their creed.

Even the well-meaning clergyman may be harmful. The religionist *sees no limit* to power engendered or conceived, whether organic or mystic; *hence may be dangerously optimistic*. Scientists, *i.e.*, psychologists and physicians trained in the disease of mind and nervous system, appreciate the limitations of physical and mental power and exhibit at least due caution.

A large part of human suffering is well known to be due chiefly to disordered states of mind. Every thoughtful person can recall instances where a series of misapprehensions, broodings, false interpretations, inexact, oversolicitous self-observations, have created painful and damaging impressions.

This is due to the fact that too few are equipped with that measure of robust, well-balanced mentality, constituting judgment, which can usually be relied upon to steer one through the long series of trials and perils that come to all of us. Again, it often happens that, owing to physical weaknesses caused by temporary bodily ailments, or by original or induced peculiarities of mind, especially by erroneous education, emotionalism, etc., a psychic condition is produced analogous to progressive mental disease. This should be treated precisely

like a physical illness: by *accurately determining its exact nature, causation, and type*, then skillfully applying the right remedies or procedures.

The first step in psychotherapy is to ascertain the facts. These must include first the physical states and next the mental. Upon the physical states much of success may depend. Memories being treacherous, it is desirable to place the individual in a position of ease, and *en rapport* with the examiner. The object being to learn all the essential facts he must become familiar with phenomena of mental life, both normal and abnormal. This anamnesis is best obtained by supplying the conditions needful to secure attention, co-operation, willingness to confide, however much of mental reservation may subconsciously exist. Among these conditions are monotony and limitation of voluntary movement. "Any arrangement of external circumstances tending to produce monotony and limitations of voluntary movements, brings about a subconscious state of suggestibility in which the patient's mental life can be affected with ease. . . . Consciousness is then vaguer than in the full waking state, memory is more diffused, so that experiences apparently forgotten come in bits and scraps to the foreground of consciousness. Emotional excitement becomes calmed, voluntary action passive, and suggestions meet with little resistance." (Boris Sidis.)

How far disorders of the mind can exist independent of impairments of nutrition or structural changes in this organ, is not as yet fully determined.

"While insanity has been defined as a departure from the normal standard of thinking and feeling, no

mental conception or psychical manifestation can occur except through the medium of the brain" (Sajous).

A large number of disorders of the processes of thought as well as of the body are known to yield to measures directed to the mind. There is much evidence to the effect that by means of direct or *indirect appeal*, *judicious explanation*, *direction*, *encouragement*, a mind originally well endowed, trained and poised can, when disordered, be brought back to the norm.

A mind fully aware of its own needs and unreservedly desiring relief may be rehabilitated by *reason*, *consolation*, *persuasion* and other suitable *stimulation* or *sedation* from without, and when adequately trained also from within.

Commoner and more stubborn mental problems arise in those who possess too little of primary equipment, are lost in a maze of doubt, depression, fear or terror producing misinterpretation of their status. There are also to be considered the environmental factors which make or mar mental efficiency, habits, beliefs, and conduct.

Since earliest history more or less convincing evidence has been adduced that mental disorders yield to *confident domination*, to *influences which seize and hold attention*, *excite wonder*, *awe*, *reverence*, *hope* or *expectation*. Of late years there has been a notable recrudescence of mind cures of divers forms.

The conditions which promise most results from psychotherapy are the functional nervous disorders. These are disorders of which no definite physical causes can be determined.

The functional psychoneuroses are

graphically classified by F. W. Langdon thus: The keynotes of **hysteria** (pithiatism of Babinski) are retraction of the field of consciousness wholly, or in part, with suggestibility a necessary causal and curative factor: the patient cannot *will* right. In **neurasthenia** there are varied morbid suggestive sensations and undue fatigability, with defective nutrition and metabolism as a basis: the patient cannot *feel* right. **Psychasthenia** is marked by morbid fears, anticipations, and impulsions: the patient cannot *think* right.

Psychotherapy is applicable in many morbid conditions connected with various organs as well as with the nervous system. Patients liable to benefit by psychotherapy are those who complain of symptoms which are out of proportion with the objective findings; especially is this the case with gastrointestinal disturbances. Further, the persons who are fatigued and easily become exhausted, who find that they forget their malaise and exhaustion in pleasant company. Further, persons who worry and dread, who are afraid they will not sleep and consequently do not. Slight actual or imagined organic trouble maintains the neuropathy. Thomas (*Revue méd. de la Suisse Rom.*, Mar., 1912).

A fair proportion of individuals are best influenced by a plain, common-sense, sympathetic, heart-to-heart, man-to-man conference. A basis of frank *camaraderie* serves best if the operator be qualified to exert it and the subject will lend himself to the task. A man or a woman of adequate authority, experience, skill appeals strongly to one of similar sex as a rule. A man can often exercise more masterful qualities, a woman usually more of sympathetic, intuitive, penetrative force. Indeed,

the special makeup, personality of the operator exerts more influence oftentimes than acquired qualifications, other things being equal.

However, the best results may be frequently attained by astuteness, persistence, keenness of apperception and *kindly dominance*. Every physician employs suggestion more or less in his daily work. Some are distinctly aware of doing so, and use good judgment. Others make the mistake of overdoing both affirmation and negation; worse than all is any form of flippancy or ridicule or upbraiding.

Feelings wounded by real or fancied unjust treatment may, in some children, bring on actual *neurasthenia*. Psychoanalysis by the Freud method and efforts to wean the little patient away from brooding over his injury are the main reliance. Suggestion can be successfully applied to children 2 years old and upward. The severe attitude or discipline of a tactless schoolteacher, and apparent or real neglect or unjust severity on the part of a parent, are examples of psychic trauma in such cases. The prophylactic treatment aims to change the disposition, making the child less sensitive and more self-reliant. In this respect the child is "hardened"; attempt is made to undeceive his illusions, and through a firm but loving training accustom him to meet difficulties and rebuffs. The symptomatic treatment is based on the fact that the psychical trauma acts like a foreign body, the voluntary or involuntary remembrance of which is continually calling forth the symptoms of the condition. This is best relieved by diverting the mind to other things. The best method is the so-called "awake" or "alert" suggestion, by constantly holding up before the patient the ultimate, complete cure of his ailment. This is embodied in various medicaments, believed by the child and the mother to have curative properties. In addition

a change in environment, and gaining the child's confidence by tactful kindness, with a free discussion of his condition and an answering of all questions asked will have a beneficial effect on his symptoms. Hamburger (Wiener klin. Woch., Feb. 20, 1913).

As to artificial aids to suggestion, in diagnosis or in treatment, probably the most efficacious is induction of the hypnoidal state of Boris Sidis. This opens the doors of closed chambers of the mind, and encourages suppressed emotions or anxieties, to come to the surface and be evaluated.

The writer found it possible to free the wounded from suffering by hypnotic suggestion that there was no pain or by throwing them into a hypnotic sleep. In a number of distressing instances, the immediate relief procured was most welcome. In war conditions the men respond with exceptional ease to hypnosis, only about 2 per cent. being quite refractory. An artificial deep slumber can be counted on in about 17 per cent. of cases. Even the initial degrees of hypnosis permit operations with much less anesthetic than would otherwise be required. The author's patients included Slavs, Teutons, and Italians. He does not advocate hypnosis for major operations, but chiefly for the sensory pangs of psychic origin. A single hypnotic sitting may entirely cure such pains. Podiapolsky (Paris méd., Aug. 25, 1917).

HYPNOTHERAPY ("HYPNOTISM").

Both sleep and hypnosis may be said to have evolved out of the primitive, undifferentiated, hypnoidal state, essentially a subwaking rest-state characteristic of early and lowly organized animal life. Having become useless, and possibly harmful, in higher animals, it was eliminated, and can only be induced under artificial conditions in but a fraction of the

human race, though still the normal rest-state of the lower vertebrates and invertebrates.

When the hypnoidal state is induced in man, he hovers between the conscious and subconscious, somewhat as one hovers between wakefulness and sleep. The subject finally falls into a subconscious condition in which outlived experiences are easily aroused. As Boris Sidis puts it, "experiences long submerged and forgotten rise to the full light of consciousness . . . in bits, in chips, in fragments, which may gradually coalesce and form a connected series of interrelated systems of experiences apparently long dead and buried. The resurrected experiences then stand out clear and distinct in the patient's mind."

Susceptibility to hypnotization, though about equal as to the sexes, predominates in subjects who readily obey, hysterics, and children, for example, and in those who most readily can concentrate expectant attention and confidence. The insane, low-grade idiots, and some hysterics who are unable to exercise continuous attention are not hypnotizable by ordinary means; nor is the militant skeptic.

After a subject has been hypnotized he is more susceptible to hypnosis, and may even enter a state of pure subjectivity to the operator—rendering hypnosis very dangerous when the operator happens to be unscrupulous. The susceptibility may become such that a mere hint, or sound, or flash of light, etc., may suffice to bring on the condition. Inasmuch as the hypnotized subject is highly susceptible to suggestibility, accepting unquestioningly the dictum of the

operator, he or she becomes the mere tool or puppet of the latter.

From the medicolegal standpoint hypnosis does not deprive the subject of will-power to the point of committing a crime which he would not commit under other circumstances. The hypnotized individual is responsible for criminal deeds which he may commit, and even slight attenuation of the responsibility can be admitted only when the individual has been in the habit of being hypnotized frequently so that a special hypersensitiveness may have developed. Babinski (*Semaine méd.*, July 27, 1910).

Technique.—The following method will meet the needs of the physician: The patient should be given a clear explanation of the nature of hypnosis, viz., that it is nothing more than a condition into which the patient voluntarily places himself by allowing his mind to follow the physician's suggestion to the exclusion of every other thought; that he will never put him to sleep without his consent and desire. That, after he is asleep, the suggestions made will be such as to enable him to keep his mind off of himself or his ailments, and that there is nothing mysterious about the process. This introductory instruction protects the physician should any medicolegal question arise against him. A third person, if possible brought in by the physician, should be present, particularly when the patient is a woman. Sensual hallucinations being common in them, especially where hysteria exists, perfectly sincere, though utterly unwarranted, accusations may result.

Several methods of inducing hypnosis are available. The patient being comfortably seated, that of Braid may be practised. This consists in re-

questing the patient to fix his eyes intently upon some bright object, a button, for example, some six inches from the eyes and in such a way as to cause the latter slight strain. It is this strain which, reflexly and through the intermediary of the neural lobe of the pituitary body according to Sajous, produces the hypnotic state. What are termed "passes"—the operator standing in front of his subject and stroking downward repeatedly from the forehead to the knees, close to, but not touching the body, are then practised. Their soothing effect, though unexplained so far, is undoubted. Simultaneously, the patient is enjoined to go to sleep by some such sentence as "Sleep is coming on; your eyelids are getting heavy; you begin to feel drowsy; the drowsiness is deepening; your arms are beginning to feel numb and heavy; my voice seems farther away; your sleep is becoming deep, soothing and restful; you are now sleeping deeply and cannot open your eyes." Inability to open his eyes on being told to do so marks the time when the patient, resting quietly, is ready for therapeutic suggestions.

Several other methods have been employed. Luys caused the patient to look fixedly at small mirrors fitted to the revolving arms of an apparatus operated by clockwork. Thus, at the Charité, he could hypnotize simultaneously many patients. Bernheim fixed the patient's gaze with his own and suggested sleep by means of sentences similar to those recorded above. Pressing gently on the eyeballs and suggesting sleep suffices in sensitive subjects. Charcot sometimes employed flashes of vivid light, loud sounds, etc., but any practice

entailing surprise or shock should be avoided.

Deep hypnosis, seldom practicable, is unnecessary in most instances. Charcot has divided hypnosis into three phases. In the *lethargic phase*, the highest form of hypnosis, the temperature, pulse, and respiration are not affected, though some degree of analgesia is present. The patient hears the operator's voice and responds readily. In the *cataleptic phase*, the limbs, as in catalepsy, retain the position, even though awkward, in which they are set by the operator, but if they are set in motion, in rotation for instance, the movement will continue indefinitely. Here the analgesia is complete. In the *somnambulant phase* the operator controls absolutely the subject, who hears and obeys only him, unless instructed by him to hear others. Commands are executed irrespective of their irrationality or moral unworthiness. This is so dangerous in its possibilities as to render the use of the somnambulant phase unwarranted under any circumstance.

The patient is easily aroused when hypnosis is not pushed to the somnambulant phase. A puff of air in the face, a command to awake while stroking the head, the suggestion that in one-half minute he will open his eyes and find himself awake and feeling quite well; raising the eyelids and calling the patient by name are the best means to employ. If left to himself, the patient will awake after a time, varying from a few minutes to several hours.

THERAPEUSIS.—Although hypnotism has been tried and claimed all-curative in many ills, it is only as an auxiliary that its use is warranted in

a few disorders. It should, in fact, be avoided wherever possible, and only considered as a means to render psychotherapy more effective and to afford psychic reparative rest.

The hypnoidal state has been utilized almost from the very origin of animal life for the repair and restoration of worn-out organs and impaired functions. We can still use this state to bring about a greater vigor of personal activity, a more efficient control of reactions to stimulations, a better adjustment of the organism to the conditions of its environment. Boris Sidis (Boston Med. and Surg. Jour., Sept. 9, 1909).

Its use by laymen should not be countenanced; what harm has been done being attributable to them, in most instances.

It is in clearly determined **hypochondria** where psychotherapy has failed to impress the sufferer that hypnotic suggestion sometimes proves the only efficient resource. **Insomnia**, where the continuous use of soporifics is contraindicated, also finds a potent help in it, particularly if some inert powder is taken in a glass of water before it is induced. It has been recommended in **hysteria**, but hysteroepilepsy has followed its use in this disease (Van Eeden). Aphasia (Charcot) and hysterical convulsions have also been known to follow it.

Numbers of hysterical individuals have been cured after they have been hypnotized, but psychotherapy waking would have been equally effectual in all, unless the hysterical patients had clamored for hypnosis. Babinski (Sémaine méd., July 27, 1910).

Neurasthenia is also benefited, but only where psychogenic phenomena tend to perpetuate the disorder after the nervous lesions have been adequately treated by classic measures.

Where unwarranted dread of death and other **phobias** and **obsessions** fail to yield to psychotherapy, hypnosis has often proved effective; also in psychogenic **impotence** and **enuresis**.

At one time much value was attributed to hypnosis as an anesthetic, but experience has shown that it is unreliable.

J. MADISON TAYLOR,
Philadelphia.

SULPHONAL.—Sulphonal (sulfonyl, diethylsulphonedimethylmethane), officially termed *Sulphonmethanum*, is obtained from anhydrous acetone by anhydrous ethylmercaptan with a stream of dry hydrochloric acid gas. It is represented chemically by the formula $(CH_3)_2C(SO_2C_2H_5)_2$. It occurs in thick, tasteless, odorless, colorless prisms, soluble in 360 parts of cold and in 15 parts of boiling water, in 47 parts of cold alcohol, and in 2 parts of boiling alcohol, in 45 parts of ether, and in 16 parts of chloroform. Sulphonal is not affected by any of the ordinary acids (even when concentrated), by alkalies, or by oxidizing agents, either in the cold or when warm, and is a very stable compound. It was introduced by E. Baumann in 1886, and clinically reported upon as a hypnotic by A. Kast in 1888. The dose of sulphonal is 10 to 45 grains (0.6 to 3 Gm.), 15 grains (1 Gm.) being that officially mentioned as the average dose. Kast advised that 15 grains (1 Gm.) be considered the maximum dose in women, and 30 to 45 grains (2 to 3 Gm.) in men.

MODES OF ADMINISTRATION.—On account of its insolubility and slow rate of absorption when given in capsules or suspended in

mucilage or simple elixir, sulphonal is preferably administered in hot fluids, such as hot water, milk, tea, broth, or bouillon. Its action is likewise to some extent accelerated by its ingestion in some alcoholic fluid, such as whisky or brandy, alcohol, especially if warmed, dissolving the drug with relative ease. Stewart found the action of sulphonal greatly hastened when it was completely dissolved in boiling water and drunk as soon as the water cooled to a bearable temperature, a teaspoonful of *crème de menthe* or other liqueur being added for flavoring purposes. Sulphonal should preferably not be given in solid form.

PHYSIOLOGICAL ACTION.—

Sulphonmethane and its congener, sulphonethylmethane (trional), both induce in therapeutic doses quietude and sleep, without any disturbance of the heart or medullary centers. Their action is practically limited to hypnosis, no effect on pain, where such exists, being produced. They have also been used, however, to check nausea, as in seasickness, and in abnormal psychic excitation among the insane have proven of value as active brain sedatives. The effect of sulphonal on the spinal cord in doses larger than the usual therapeutic amounts is well illustrated in dogs, to which the drug is administered, pronounced staggering of gait and relaxation of the muscles soon resulting.

Absorption of sulphonal is very slow, as long as 2 or 3, and occasionally as much as 5 hours or more, not infrequently being required for the induction of sleep. The sleep induced by 20-grain (1.3 Gm.) doses, once established, tends to persist all night. Excretion is correspondingly

slow, and the patient often remains drowsy on the following day. Often the single dose of the drug will induce sleep on the second night, and in a few instances even on the third. Sulphonal and trional—which acts more rapidly—are eliminated as ethyl sulphonates.

The continued administration of sulphonal for more than three successive days at times imparts the impression of a cumulative action, increasing somnolence and lassitude resulting from the slow elimination of the drug and its continuous action on the central nervous system.

CONTRAINDICATIONS.—Sulphonal should not be given, or be used with caution, in cases exhibiting great prostration, in cases suffering from gastrointestinal disturbance (especially in constipation), in old age, and in cases of severe cardiac disease or in nephritis.

UNTOWARD EFFECTS AND POISONING.—Unpleasant after-effects have at times followed the use of sulphonal in ordinary therapeutic doses. There is not infrequently more or less cerebral heaviness and distress the next day. Giddiness may follow even 15-grain (1 Gm.) doses, and after 20 grains (1.3 Gm.) or more, headache and inco-ordination of gait are sometimes observed. Among other less frequently observed symptoms have been tinnitus, muscular weakness, nausea and vomiting, serous diarrhea, mental excitement, weak pulse, cyanosis, and an eruption, usually minutely papulous in character, occasionally bullous, and, according to Erbsloh, often showing a disposition to follow the nerve-trunks. These untoward effects, as a rule, pass off rapidly, with

the occasional exception of the disturbance of co-ordination.

Acute sulphonal poisoning has been met with many times, but only rarely with fatal results. Neisser, Hirsch, and Richmond have reported cases in which recovery followed ingestion of $3\frac{1}{2}$ ounces (100 Gm.), $6\frac{1}{2}$ drams (25 Gm.), and 2 drams (8 Gm), respectively. Another writer reported the case of a man who took 3 tablespoonfuls of sulphonal, with recovery after five days. Gillett recorded a case of poisoning by 1 dram (4 Gm.) of sulphonal taken in 3 equal doses by a neurotic girl of 17 years, with recovery. Hill reported the case of a child of 18 months who received 34 grains in a few hours, with recovery. On the other hand, Marvin has reported a death after ingestion of 4 drams (16 Gm.) of sulphonal in 5 doses—2 taken one afternoon and 3 the next morning. Hoppe-Seyler and Ritter reported a death from $1\frac{1}{2}$ ounces (50 Gm.) of the drug. Pettit recorded a death in 40 hours from 30 grains (2 Gm.) in an hysterical, melancholic woman of 28 years; she had, however, received chloral hydrate, cannabis indica, potassium bromide, and paraldehyde on the preceding day. In cases of postinfluenzal debility Grant observed prostration and circulatory depression from single 20-grain (1.3 Gm.) doses. Otto referred to cases in which walking was rendered difficult or impossible under the use of 75 grains (5 Gm.) of the drug. Sleep lasting 75 hours has been produced by 1 dram (4 Gm.).

The symptoms of acute sulphonal poisoning include dizziness, inco-ordination, heavy sleep or actual unconsciousness, slight reddening of the face, gastric pain and anorexia,

vomiting, diminution or loss of reflexes, constipation, rapid respiration, frequent and weak pulse, cyanosis, and analgesia of the lower extremities. Psychic excitement, hallucinations, muscular twitchings, swelling of the extremities, and an itching, papular exanthem have also at times been noted. In Hirsch's case nephritic manifestations were noted on the fourth day, lasting for three days. Fever has occasionally preceded death, which results from cardiac failure.

A woman, aged 27, suffering from melancholia, took 365 grains (24.4 Gm.) of sulphonal in tablets. When first seen she was comatose. The pulse was 80 and feeble, the respirations 15, and the temperature 98° F. (36.7° C.). The corneal reflex, kneejerks, and radial reflex were absent. The pupils were slightly contracted and reacted sluggishly. The stomach was washed out. The urine was drawn and found clear and abundant. By evening the corneal reflex had returned. She could be aroused to take hot coffee. Next morning cyanosis set in. The pulse was accelerated and the temperature rose to 103.5° F. (39.7° C.). There were no physical signs of pneumonia. On the third day she was improved. A sweet, chloroform-like odor was noticed on the breath soon after she had taken the dose, and with the first urine evacuated the same odor was obtained. On the fourth and fifth days cerebation was markedly interfered with and the speech staccato. After eight days she was mentally more active, and convalescence set in. A. E. Hind (Lancet, Jan. 23, 1904).

Treatment of Acute Sulphonal Poisoning.—This consists of **immediate evacuation of the stomach and purging**. The kidneys should be encouraged to act freely by **ingestion of water and saline enteroclysis**. Stim-

ulants such as **strychnine**, **atropine**, **aromatic spirit of ammonia**, **digitalis**, etc., may prove of distinct value. **External heat** and **artificial respiration** are also measures to be thought of in serious cases.

Chronic sulphonal poisoning has, in the past, proven more common and dangerous than the acute form. From 1888 to 1900 about 30 fatal cases and 50 non-fatal severe cases were reported—mostly in lunatic asylums. The amount necessary to cause poisoning varies greatly. Fifteen hundred grains in 6 years, 224 Gm. ($7\frac{1}{2}$ ounces) in 205 days, 128 Gm. ($4\frac{1}{4}$ ounces) in 91 days, and similar amounts have frequently been taken without ill effect. On the other hand, death has occurred after 16 Gm. (4 drams) in 1 month, and 90 Gm. (3 ounces) in 3 months, and severe poisoning after 180 Gm. (6 ounces) in 270 days, 132 Gm. ($4\frac{1}{3}$ ounces) in 120 days, etc. Women are more commonly poisoned than men, and poor diet, age, and debility (anemia), all increase the tendency. Constipation especially favors poisoning (Dietrich). Nearly all the fatal cases have occurred in people who were habitually constipated (Gulland).

The first symptoms of chronic sulphonal poisoning to appear are usually gastrointestinal—anorexia, thirst, nausea, vomiting, and especially constipation, which may be followed by diarrhea. There may be epigastric pain, an acetone odor of the breath, cardiac weakness, and a skin eruption. Lassitude is marked, but drowsiness is usually not a very prominent symptom until the final stage is reached. After the gastrointestinal symptoms appear, as a rule, nervous manifestations, such as

ataxia and, less often, paralysis of the extremities or facial muscles, or even localized or general convulsions. Mental apathy and depression, with cutaneous anesthesia, often accompany the motor symptoms, in the fatal cases passing into coma before death. Either early or late, characteristic changes appear in the urine, which becomes scanty and dark-red in color ("port-wine coloration"), owing to the presence in it of the abnormal blood-pigment hematoporphyrin. Certain identification of the latter is best carried out with the spectroscope, which reveals definite absorption bands signifying the presence of the pigment. The urine may or may not contain albumin, casts, degenerated blood-corpuscles, and much urobilin (Talley). According to Gulland it is always intensely acid, and contains unchanged sulphonal. Death may be preceded by delirium or stupor and gradually developing motor and sensory paralysis, and takes place usually from respiratory, sometimes from cardiac, arrest.

Unmistakable multiple neuritis has been reported as caused by the continued use of sulponal (Erbsloh).

A pale patient, 32 years of age, of fair physique, had been suffering from chronic mania for two years. When she became acutely maniacal, as upon previous occasions, sulphonal was administered in 30-grain (2 Gm.) doses daily for one week. Twenty-eight hours after the last dose she refused her breakfast, and vomited shortly afterward. The skin was cold and clammy, pupils normal, pulse 86, of low tension and somewhat irregular. Temperature sub-normal. The gait was unsteady, articulation was slow, and the mental condition clearer than it had been for months. The urine was of a deep port-wine color. Flaccid paralysis in

the legs spread rapidly upward until the patient was barely able to turn her head. A varying amount of anesthesia was present. The muscles were tender, and shooting pains complained of in the legs. Bullæ appeared over the body; the superficial and deep reflexes were lost. The bladder and rectum were emptied involuntarily. The act of swallowing became gradually more and more impaired, the respirations were imperceptible, and speech a mere lisp. The patient's mind remained clear until her death on the fifth day. H. de M. Alexander (Jour. Mental Sci., Oct., 1902).

Over 47 cases of hematoporphyrinuria from sulphonal are upon record, also 7 cases due to trional and 2 to veronal. Fatalities from sulphonal have occurred without hematoporphyrinuria. The author's case occurred in a woman of 30, apparently suffering from the maniacal phase of manic depressive insanity. She had refused all medication *per os*. Sulphonal was then mixed with the food. She ingested some 4 Gm. (60 grains) daily for two days, then half that daily dose for several days more. At most not over 10 Gm. (2½ drams) of the drug found their way into the body. The woman now became very constipated. For the first three days following the last dose of sulphonal no urine was voided. On the fourth day urine of the characteristic port-wine color was passed. After this duhoisine (0.005 Gm.— $\frac{1}{42}$ grain) was given. On the fifth day she collapsed, complained of abdominal pressure, and died a few hours later. At autopsy the kidneys were found normal. The real causes of death were doubtless the constant agitation of nearly two weeks' duration and the defective alimentation and fatty state of the myocardium. Pförtner (Deut. med. Woch., July 30, 1914).

Treatment of Chronic Sulphonal Poisoning.—The first care should be to empty the bowel thoroughly. Even

croton oil may be used, to secure immediate results. To promote elimination through the kidneys, saline solution may be given by enteroclysis, by hypodermoclysis, or even by intravenous infusion. Large enemata of warm water, as well as free use of water by the mouth, have been advocated. Alkalies, such as sodium bicarbonate and sodium acetate or citrate, or magnesium carbonate, should be given in sufficient amounts to render the urine alkaline; this measure controls the hematoporphyrinuria (Gulland). If a hypnotic is necessary, morphine and scopolamine, or small doses of chloral hydrate, may be given (Wood). Stimulants should be given as soon as cardiac depression appears. In all but slight cases the prognosis is relatively bad. Günther collected 47 cases, with a mortality of 53 per cent. Convalescence is slow.

A point in the prognosis of chronic sulphonal poisoning is the observation that all the cases that have recovered have had some or all of the gastrointestinal, nephritic, respiratory, and circulatory symptoms, but no nervous symptoms beyond stupor and ataxia. The development of paresis appears always to run on to complete paralysis and death. The predominance of constipation among the toxic cases should put one on the alert to keep the bowels active during the exhibition of the drug. Yet free purgation is not able to eliminate the poison when once absorbed and the mischief begun. Smith's case had diarrhea the greater part of the twelve days between the first signs of poisoning and death. J. E. Talley (Amer. Jour. Med. Sci., Oct., 1908).

THERAPEUTICS.—Sulphonal is a fairly reliable hypnotic, having little or no analgesic effects, and rank-

ing below chloral hydrate in power and certainty of action. It is advantageous in being odorless and tasteless, and can be administered to obstinate patients in food without their knowledge.

In **functional nervous insomnia** it is valuable as a hypnotic except when the presence of advanced organic disease of the heart is the cause of the wakefulness, in which case it is dangerous. The slowness of its action necessitates its administration about 2 hours before bedtime if an immediate hypnotic action upon retiring is desired. In such instances the more rapidly acting trional, or veronal, are more convenient drugs. In the class of patients, however, who have no difficulty in going to sleep on retiring, but later lie awake for several hours or until morning, sulphonal, ingested at bedtime, may be more efficient than trional, its effects, later in appearing, being more likely to continue throughout the night. On the other hand, there is less heaviness the next day after sulphonal than after trional. The action of sulphonal often lasts two nights after use. Mairet recommends the giving of one relatively large dose the first night, followed by diminishing doses on succeeding nights.

In the **insomnia of insanity**, sulphonal generally acts well, producing sleep by night and quietness during the day, its slow, persistent effect at times giving results superior to those obtained with the more rapidly acting drugs. Webber recommends the use of 5-grain (0.3 Gm.) doses 3 times a day, and if necessary, during the night, to quiet restlessness in **neurasthenia, hysteria, and mania**. To combat intense excitement in the in-

sane, doses of 45 to 60 grains are sometimes required. In somewhat less excited maniacs and agitated melancholics 40-grain (2.5 Gm.) doses, given in hot milk at bedtime, act well (Sutcliffe).

Some cases of persistent **hiccough** have been relieved by sulphonal, which has also proven effectual in nocturnal seminal emissions. Andrews found it more sedative than opiates in a case of **painful muscular spasm** after fracture of the thigh. Shaw-MacKenzie has recommended its use in a dose of 10 to 15 grains (0.6 to 1 Gm.) to relieve **seasickness** and **carsickness**, and Rosenberg cut short a paroxysm of **bronchial asthma** with it. Lépine has used it in **chorea**.

In the **night-sweats of pulmonary tuberculosis**, except in the very advanced stages, sulphonal in 15- to 30-grain (1 to 2 Gm.) doses has been found efficient, cough being simultaneously diminished.

In **diabetes mellitus** sulphonal causes, like many other sedatives, a diminution of glycosuria, which is, however, only temporary. To prevent chronic sulphonal poisoning, sulphonal should preferably not be given continuously, or, if it is, frequent intermissions of from 4 days to a week imposed. Care should be constantly taken to secure proper action of the bowels and kidneys. If such symptoms as nausea, vomiting, gastric pain, etc., the drug should be promptly withdrawn.

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SULPHUR.—Sulphur is a non-metallic, solid element found native in the western United States, Mexico, Iceland, and in the West Indies, but more abun-

dantly in Sicily and Italy, whence the commercial supply chiefly comes. It is an important constituent of certain native mineral springs which furnish sulphurated waters. When fused and cast into rolls or cylinders it is popularly known as brimstone. As it occurs in nature, it forms yellow, transparent, rhombic crystals. Sulphur emits a peculiar odor when rubbed, and has a very faint taste. It is insoluble in water, but soluble in benzine, benzene (benzol), turpentine, ether, chloroform, carbon disulphide, the fixed and volatile oils, and in boiling alkaline solutions.

PREPARATIONS AND DOSES.—

Sulphur lotum, U. S. P. (washed sulphur), prepared from flowers of sulphur by washing with ammonia, which frees it from acid. It occurs as a fine, yellow powder, odorless, tasteless, and insoluble in water. Dose, 15 grains to 1½ drams (1 to 6 Gm.); average 1 dram (4 Gm.).

Sulphur præcipitatum, U. S. P. (precipitated sulphur, milk of sulphur, lac sulphuris), prepared by precipitation from a solution of alkaline sulphide. It occurs as a pale-yellow powder, odorless, tasteless, and insoluble. It is soft, and not gritty like washed sulphur, and is therefore preferred in the preparation of lotions and ointments. Dose, 1 dram (4 Gm.).

Sulphur sublimatum, U. S. P. (sublimed sulphur, flowers of sulphur, brimstone), occurring as a fine, yellow powder, or sulphurous odor and faintly acid taste, insoluble in water. It has been preferred for laxative purposes, as it contains free sulphurous acid and is gritty, but it may contain arsenic. Dose, 1 dram (4 Gm.).

Pulvis glycyrrhizæ compositus, U. S. P. (compound licorice powder; pectoral powder), containing 8 per cent. of washed sulphur, 18 per cent. of senna, and appropriate amounts of licorice, oil of fennel, and sugar. Dose, ½ to 2 drams (2 to 8 Gm.); average, 1 dram (4 Gm.).

Unguentum sulphuris, U. S. P. (sulphur ointment), containing 15 per cent. of washed sulphur in benzoinated lard. Used externally.

Calcii sulphidum crudum, U. S. P. (sulphurated lime; "calcium sulphide"). Dose, 1 grain (0.06 Gm.). (See CALCIUM).

Potassa sulphurata, U. S. P. (sulphurated

potash; "potassium sulphide"; liver of sulphur; crude potassium sulphide), a mixture of potassium salts of which the chief are sulphides, prepared by fusing dried potassium carbonate with sublimed sulphur. It occurs in hard, brownish masses of liver-brown color with a strong odor of hydrogen sulphide and a bitter, alkaline taste. It deteriorates gradually on exposure to air. It is soluble in 2 parts of water. Alcohol dissolves only the potassium sulphide, leaving the sulphate and thiosulphate undissolved. It is incompatible with acids, including carbon dioxide, and with alcohol. The sulphides in it correspond to 12.8 per cent. of sulphur. Used externally.

Recognized in the National Formulary:—

Sulphuris iodidum, N. F. (sulphur iodide), consisting of 1 part of sulphur to 4 parts of iodine, fused in brittle, grayish-black masses of crystalline structure, insoluble in water, soluble in carbon disulphide and in 60 parts of glycerin. Used externally in a 10 per cent. ointment.

Unguentum sulphuris compositum, N. F. (compound sulphur ointment; Wilkinson's ointment; Hebra's itch ointment), consisting of precipitated calcium carbonate, 2 parts; sublimed sulphur and oil of cade, of each 3 parts, and soft soap and lard, of each 6 parts. Used externally.

Liquor calcis sulphurata, N. F. (solution of sulphurated lime; Vlemminckx's solution or lotion), a mixture of lime, 16.5 parts, and sublimed sulphur, 2.5 parts, dissolved in boiling water, to make 100 parts.

Sometimes used, but not officially recognized, is the following:—

Colloid sulphur, made by passing a current of well-washed hydrogen sulphide through sulphurous acid until the latter is entirely decomposed and a suspended precipitate of colloid sulphur is formed. The resulting mixture is then dialyzed to remove the polythionic acid by-products preventing solution of the colloid sulphur. The preparation is then standardized to contain 6 grains (0.04 Gm.) of sulphur to the ounce. Dose, ½ ounce (15 c.c.) twice daily with meals.

PHYSIOLOGICAL ACTION.—Locally, sulphur, if in prolonged contact with the skin, and especially if rubbed into it either in an ointment or a suspen-

sion, produces stimulation and later irritation, which may eventuate in actual inflammation or dermatitis. This is due to its conversion by the skin secretions into sulphides. Exfoliation of the epidermis is augmented by the local stimulating effect of sulphur—a property frequently utilized in therapeutics. Sulphur is also a parasiticide and is mildly antiseptic.

Taken internally, sulphur may slightly irritate the stomach if the latter be empty at the time. It is insoluble in the acid medium of the stomach. Entering the intestine, it is in part dissolved by the alkaline intestinal juices and absorbed, but most of it is gradually changed by the proteins of the alimentary tract into sulphates, which are then reduced to sulphides, including hydrogen sulphide. Some of the latter is absorbed into the circulation and is excreted by the lungs, skin, kidneys, and mammary glands. The breath may thus acquire to some extent the characteristic odor of hydrogen sulphide, and silver articles worn by the patient be quickly tarnished. An increase in the sulphates of the urine is noted.

Sulphur, ingested even in small amounts, is held to exert a definite antiseptic action in all parts of the intestine, owing to the formation of hydrogen sulphide. Heffler found that when sulphur is brought into intimate contact with fresh intestinal mucous membrane, hydrogen sulphide is soon formed; boiling does not destroy this action, which therefore occurs independently of bacterial action. Administered in larger amounts, sulphur increases peristalsis without causing pain, and produces soft stools, acting as a mild laxative. It is believed also to increase intestinal secretion by its slight irritant action. Sulphur is, however, without action on the digestive enzymes. A favorable action upon the mucous membranes, in particular those of the respiratory tract, has been attributed to sulphur.

According to Brisson (1909) sulphur preparations are rendered more active by the presence of the agencies which accelerate the liberation of sulphuric acid (sulphates) from it, such as sodium chloride, increased temperature, electricity, and in particular blood (horse) serum. Fineness of mechanical subdivision is also

a favoring factor, precipitated sulphur being more active than sublimed sulphur, and colloidal sulphur than the first named.

UNTOWARD EFFECTS AND POISONING.—Toxic effects consist of nausea, diarrhea, muscular cramps in the limbs, fever, and painful urination. In one case recorded there was extreme prostration, together with a sulphurous breath, cold perspiration, abdominal pains, and vomiting and purging. Long-continued administration of sulphur causes depression (R. B. Wild).

Carbon bisulphide, liberated in the vulcanization of rubber, produces such symptoms as headache, dizziness, anorexia, insomnia, formication, nervous depression, dyspnea, deafness, and febrile attacks, apparently due to a direct action on nervous tissues.

Sulphur dioxide, set free in large amounts from factories, and used in bleaching fabrics, causes bronchial irritation and anemia.

Hydrogen sulphide, liberated in chemical laboratories, is capable of producing chronic poisoning characterized by depression and weakness, slow pulse, anorexia, furred tongue, and anemia.

Illuminating gas contains sulphur compounds, which, according to Haldane, are responsible for the unpleasantness of air vitiated by its combustion.

Treatment.—This consists in the removal of the cause and, where gastrointestinal symptoms are acute, the use of **purgatives** followed by **bismuth**. Remedies to counteract nervous or circulatory depression and anemia may be indicated. **Opium** to allay pain and control peristalsis may sometimes be required.

THERAPEUTICS.—**Gastrointestinal and Constitutional Disorders.**—Sulphur has been used as laxative chiefly in cases of **hemorrhoids**, **fissure at the anus**, and **partial intestinal obstruction**, owing to the soft, pulpy stools it induces without, on the other hand, producing large, watery evacuations. It may either be given by mouth or, most pleasantly, as a suppository, to be inserted at night. If used by mouth, washed sulphur may be given, *e.g.*, in a 45-grain (3 Gm.) powder at bedtime, mixed, if desired, with syrup or molasses; or 7½ grains (0.5 Gm.) each

of sulphur and magnesium oxide may be given in a wafer 3 times a day after meals. Sulphur lozenges each containing 5 grains (0.3 Gm.) of the drug are official in the British Pharmacopeia.

Sulphur has been recommended in 5- to 20-grain (0.3 to 1.3 Gm.) doses as a stimulant to the hepatic functions, where these are disordered or suspended. Perhaps greater justification attends, however, its use in small doses as an intestinal antiseptic, *e.g.*, in the **diarrhea of scrofulous children**, with offensive, watery stools, in **intestinal indigestion** and **fermentation**, in **amebic dysentery**, etc. Maillard has called attention to the rôle of sulphur in neutralizing the phenol derivatives arising in the intestine from putrefactive decomposition of residual proteins. This influence and the antiseptic action of sulphur doubtless account in part for the benefit at times witnessed in affections of the rheumatic type, including **chronic rheumatism**, localized **myalgias** and **neuralgias**, **rheumatoid arthritis**, and **gout**. The dose given may be small and repeated 3 times a day, or a larger amount may be administered once daily to secure both the laxative and "alterative" action.

External use of sulphur, in the form of baths in mineral waters containing it, has been credited with distinct remedial properties in **chronic rheumatoid** conditions as well as in **syphilis** and various skin affections. According to Brown (1911) sulphur-water causes a manifest increase in general oxidation and tissue metabolism, the total nitrogenous output, in his experiments, having been augmented by 8 per cent.; the output of phosphates, 10 per cent.; that of endogenous (body tissue) creatinin, 13 per cent., and that of endogenous uric acid, 18 per cent. He believes the drug causes an "enormous" stimulation of the xanthin oxidase of the liver. Ullmann has emphasized the value of sulphur baths in chronic affections of the fasciæ, joints, and muscles, and F. W. Smith employed electrolytic transmission of sulphur from Harrowgate waters by means of the constant current through the skin of patients with **rheumatism**, **gout**, **peripheral neuritis**, and **eczema**, with results superior to those obtained without the electrolytic transmission.

In **lumbago** and **sciatica** it has been advised to apply to the affected part the flowers of sulphur, retained by a bandage.

Intravenous and intramuscular injections of colloidal sulphur administered in **subacute rheumatism** with prompt and complete results, even deformity showing retrogression. A. Cawadias (Bull. de l'Acad. de méd., Sept. 25, 1917).

The writer injects 5 c.c. (80 minims) of a 1 per cent. solution of sulphur in oil of sesame in **psoriasis**, with excellent results. In **syphilis**, an injection every five to eight days greatly facilitates active mercurial treatment. In a case of **gonococcic arthritis** of the knee, 3 injections of 1 to 2 c.c. (16 to 32 minims) were followed by rapid disappearance of pain and functional recovery. Sulphur injections are of value in facilitating mobilization of **stiffened joints**. L. Bory (Bull. et mém. de la Soc. méd. des hôp. de Paris, Mar. 7, 1918).

Use of calx sulphurata in **lead poisoning** has been suggested.

Respiratory Disorders.—Cases of **chronic bronchitis** are at times benefited by sulphur. G. Sée recommended the following combination in these cases:—

R. Sulphuris præcipitati, gr. i (3 Gm.).

Extracti belladonna

foliorum gr. j (0.06 Gm.).

Pulveris ipecacuanha

et opii gr. v (0.3 Gm.).

Sacchari gr. xx (1.2 Gm.).

Pone in capsulas no. x.

Sig.: Two to ten capsules a day as required.

Heubner (1908) refers to a favorable effect of sulphur spring-water taken internally in adults with **chronic catarrhal conditions of the pharynx and throat**, and especially recommends sulphur-water in the form of drink, gargle, or inhalation for the **chronic pharyngeal catarrh of children**, associated with persistent anorexia and tendency to vomit after meals, malodorous breath, constipation, anemia, and coating of the throat and back part of the tongue with tenacious, foul mucus. One wineglassful (5 ounces—150 Gm.) of sulphur-water is ordered taken cold, be-

fore rising in the morning, another half an hour later (before breakfast), and in some cases a third on retiring; the course of the treatment is continued for 4 to 6 weeks, and is effectual whether trouble has been caused by adenoids, enlarged tonsils, or other conditions.

Robin and Maillard advise the use of colloid sulphur in severe **acute or chronic inflammations of the respiratory mucous membrane** on the ground that where much mucus (the mucin of which contains 1.4 per cent. of sulphur) is being thrown off as a measure of defense against bacteria there is a great strain on the secretory structures and a general condition of sulphur starvation. They hold that, whereas the older forms of sulphur cannot be synthesized to build up protein combinations in the body, colloid sulphur can be utilized in the formation of cystin, which is the sulphur-containing component of mucus and from which are apparently built up (A. E. Taylor) the important sulphurated lipoids of the central nervous system and bile.

Chlorosis.—In chlorosis, when iron is not well borne or has failed, sulphur has been observed at times to improve the general condition, so that iron could be used with success later.

CUTANEOUS DISORDERS.—In **scabies** sulphur ointment is one of the best remedies. The official ointment should generally be diluted, to avoid skin irritation, with an equal amount of petrolatum; or, a mixture of 4 parts of sulphur with 1 part of balsam of Peru may be used. (See SCABIES.)

In **tinea tonsurans** sulphur ointment is efficient after clipping the hair. In **ring-worm of the crotch and armpits** sulphur mixed with talcum powder may be used.

Seborrhea, sycosis, chronic eczema, and psoriasis are benefited by small doses of sulphur taken internally. Inveterate forms of **eczema, psoriasis, impetigo, and prurigo** may be improved by the fumes of burning sulphur.

For **dandruff and seborrheic dermatitis of the scalp**, Brayton advises that the latter be cleansed once a week with tar-soap, and, when dry, well rubbed with a portion of the following cream the size of the end of the thumb:—

℞ *Sulphuris præcipitati* ... 3j (4 Gm.).
Acidi salicylici ʒss (2 Gm.).
Unguenti aquæ rosæ ... ʒj (30 Gm.).

M.

The same ointment may be used for **seborrheic dermatitis of the face or body**. Jackson's formula in the treatment of dandruff is as follows:—

℞ *Cera alba* ʒijss (14 Gm.).
Petrolati liquidi ʒijss (10 Gm.).
Aquæ rosæ 3j (4 Gm.).
Sodii bichloratis gr. xv (1 Gm.).
Sulphuris præcipitati.. ʒijss (14 Gm.).

M.

In **diseases of the nails**, when they have become brittle and covered with ridges and white spots, internal use of sulphur in small doses will frequently bring about a healthy and polished appearance.

In skin diseases accompanied with infiltration the use of sulphur iodide in a 6 per cent. ointment has been advised.

In scaly skin diseases, sulphurated potash is useful, 1 to 3 ounces (30 to 90 Gm.) being dissolved in 15 gallons of water, for a bath.

In suppurative skin diseases, in **acne, boils, carbuncles, glandular enlargements, etc.**, calx sulphurata (calcium sulphide) in small doses is considered of value, tending to inhibit the development of fresh lesions. It is also of use externally as a depilatory.

Sabouraud's formula for **acne** is as follows:—

℞ *Sulphuris præcipitati*.. ʒijss (10 Gm.).
Alcoholis (90 per ct.), ʒij (12 c.c.).
Aquæ destillatæ,
Aquæ rosæ āā ʒjss (50 c.c.).

M. Sig.: Shake and apply every evening.

In **acne** sulphur (precipitated) may also be used in 1 to 4 admixture with facé powder, or in 1 to 8 admixture with rose-water ointment.

Riecke points out that fine subdivision of sulphur and hence the best effects from its preparations are obtained by the use of sulphur freshly precipitated from calcium polysulphide. He recommends thorough application of such an ointment 2 or 3 times a day in **scabies, acne vulgaris, acne rosacea** of the second degree,

seborrhea, tinea versicolor, tinea tonsurans, and pityriasis rubra.

An efficient preparation of sulphur is formed by the interaction of zinc sulphate and potassium sulphide. Brayton applies the following lotion at night in acne vulgaris or rosacea:—

R *Zinci sulphatis*,
Potassii sulphidi...āā ʒij (8 Gm.).
Aquæ rosæ.....ʒxij (350 c.c.).

M. Sig.: Shake well before applying.

Voerner, in **seborrhea, acne rosacea, eczema, and follicular processes**, secures an intense sulphur action by dissolving 1 part of potassium sulphide in 2 parts of water, painting this upon the affected area, previously carefully dried and freed from fat, and as soon as the solution has dried upon the skin, spraying on vinegar with an atomizer. Sulphur is at once precipitated and adheres intimately to the skin.

According to O. H. Foerster, liquor calcis sulphuratæ is the most active of all the sulphur preparations; when this is alone in contact with the skin nascent sulphur and hydrogen sulphide are formed.

As Insecticide.—Powdered sulphur, if used as an insecticide must be applied directly to the insects, and its use is largely limited to the destruction of mites and lice. Sulphur dioxide set free by burning sulphur is, however, an efficient fumigant for all insects (see **STERILIZATION AND DISINFECTION**). Where a liquid insecticide is applicable, bisulphide of lime is an efficient agent (McClintic). Rosenau suggests the preparation of this by boiling together, for an hour or more in a little water, equal parts of flowers of sulphur and stone lime. Thus, 5 pounds of each ingredient may be boiled in 3 or 4 gallons of water until a brownish liquid is formed; the latter may be diluted to make 100 gallons. This preparation may be sprayed or poured into cracks or crevices containing roaches, bedbugs, lice, etc. S.

SULPHURIC ACID.—*Acidum sulphuricum*, U. S. P., is a clear, colorless, odorless, heavy, oily, corrosive, and hygroscopic liquid, of a specific gravity of 1.826, miscible in all proportions with water and alcohol with the evolution of heat. It should be observed that in di-

luting, the acid should be added to the water or other diluent, and not the reverse. It is one of the strongest of acids, is dibasic, and forms normal and acid salts which are generally crystallizable and soluble in water.

PREPARATIONS AND DOSES.—

Acidum sulphuricum, U. S. P. (92.5 per cent. absolute H_2SO_4). Dose, 2 to 3 minims (0.13 to 0.2 c.c.), largely diluted and taken through a glass tube or quill, and the mouth rinsed immediately with a mild alkaline solution.

Acidum sulphuricum aromaticum, U. S. P. (elixir of vitriol; contains 10 per cent. sulphuric acid with aromatics). Dose, 15 minims (1 c.c.) diluted with water, syrups, etc.

Acidum sulphuricum dilutum, U. S. P. (dilute sulphuric acid; contains 10 per cent. sulphuric acid). Dose, 15 to 30 minims (1 to 2 c.c.), well diluted.

Mistura sulphurica acida, N. F. (Haller's mixture; a 25-per-cent. solution of sulphuric acid in alcohol). Dose, 8 minims (0.5 c.c.), well diluted.

PHYSIOLOGICAL ACTION.—When applied locally, or taken in concentrated form, this acid is a strong escharotic, abstracting the water from the tissues so rapidly that they become carbonized (black eschar). Overdoses destroy the tissues of the alimentary canal, causing violent gastroenteritis with severe burning pain in the mouth, esophagus, and stomach. Collapse, followed by death, may occur quickly. If the acid has not caused perforation, death may come more slowly, and in that case Stenson's duct usually becomes occluded and inflammation of the parotid gland results. In some cases acute nephritis with hematuria occurs. If the patient recovers from the acute condition, he usually dies later from inanition, brought about either by stricture of the esophagus or disintegration of the gastric tubules.

TREATMENT OF POISONING.—As there is danger of perforation of the tissues, the use of the stomach-pump must be avoided. Mild alkaline (solutions of sodium carbonate or bicarbonate) and demulcent drinks (barley-water, flaxseed tea, thin gruel, diluted starch, oil, milk,

white of egg) should be given freely, and the pain relieved by **opiates** in sufficient dose. The bodily temperature should be maintained by the application of **external heat**. The use of **stimulants** will relieve the shock. **Magnesia, lime, chalk, plaster** scraped from the wall, may be used as antidotes, but solutions of **sodium carbonate** or **bicarbonate** are to be preferred.

THERAPEUTIC USES.—As an escharotic this acid may be employed in the treatment of **indolent ulcers, gangrene, warts, chancres** and other **venereal sores**. For the destruction of superficial **skin-cancers** Michel's paste, consisting of 3 parts of sulphuric acid and 1 part of finely powdered asbestos thoroughly triturated together, has been recommended. Similar escharotic pastes may be made by mixing the acid with charcoal (Ricord's), saffron (Velpeau's) or zinc sulphate (Smith's). A liniment containing about 1 part of acid to 3 parts of olive oil is a decided counterirritant. An ointment containing 10 per cent. of the acid may be used in **tinea capitis**. Sulphuric acid is a chemical antidote in **acute lead poisoning**, and a prophylactic in **cholera**, in doses of 5 minims (0.3 c.c.) in a wine-glassful of water, repeated.

Dilute sulphuric and aromatic sulphuric acids are practically of the same strength and adapted to the same uses. Given internally they are tonic, astringent and refrigerant, and are useful in **serous** and other **diarrheas**, combined with opium and carminatives, especially in **Asiatic cholera** and **epidemic diarrhea** in children. In the **night-sweats of phthisis** aromatic sulphuric acid is best combined with atropine in small doses.

In **pyogenic infections—carbuncles, furuncles, staphylococcic and streptococcic infections**, and also in **bronchiectasis and pulmonary tuberculosis** where there is **staphylococcic infection**—Reynold has employed with success dilute sulphuric acid, administered internally in doses of 20 to 30 minims (1.25 to 2 c.c.), diluted with 2 ounces (60 c.c.) of water, every four hours. Externally carbolized petrolatum (1 in 20) was applied. Within twenty-four hours the infiltrated area of a **carbuncle** became strictly circumscribed;

then the slough softened, the pus freely discharged, and the whole affected area shrank, and healthy granulation-tissue filled up the cavity until the part healed. In **infected wounds** resulting from abrasions, punctures, or inoculation by decomposing animal matter, treatment by dilute sulphuric acid caused the early symptoms of septicemia to rapidly disappear, the fever to decline, and the pain and swelling to subside. Recurrent crops of **boils** and severe cases of **acne** yield to internal treatment by dilute sulphuric acid; **blind boils** are aborted. In **tuberculous cases** the fluctuations of temperature are influenced and the amount of sputum is diminished.

Leo, Köhler, and Ströhl recommend the use of dilute sulphuric acid in **pruritus**, especially **senile pruritus**, and that form complicating pulmonary disease.

Haller's sulphuric acid mixture is a valuable astringent and antiscorbutic; it is also used to dissolve quinine sulphate in liquid mixtures.

SULPHUROUS ACID.—*Acidum sulphurosus*, U. S. P. VIII. is a colorless, aqueous solution of sulphurous acid (gas) containing not less than 6.4 per cent. of absolute SO_2 , having the characteristic odor of burning sulphur, and an acid, sulphurous taste.

ACTION AND USES.—In pharmacy and the arts it is used for bleaching organic matter, removing fruit-stains, for preventing putrefaction, and as a **germicide** and **disinfectant**. It arrests putrefaction and fermentation by destroying the germs which produce them. For disinfecting purposes formaldehyde has largely replaced the fumes of burning sulphur, which contains large amounts of this acid, as the former is more powerful, penetrating and persistent, and lacks the bleaching property of the latter.

Sulphurous acid, in some form, is extensively employed in many technical operations in the preparation of food—the production of wine, the preparation of evaporated or desiccated fruits, and in the manufacture of molasses. There is reason to believe that the use of sulphurous acid in foods is deleterious.

The drug is rarely employed in medi-

cine, except as a topical application in *tinea versicolor*, the undiluted solution being rubbed on the affected skin once or twice daily; if it is to be applied continuously, the acid should be diluted with three or four times its bulk of water.

Internally, in doses of from $\frac{1}{2}$ to 2 drams (2 to 8 c.c.), largely diluted, sulphurous acid has been used to some extent in the treatment of **fermentative dyspepsia with flatulence**, in **urticaria**, and in **hay-fever**. The sulphites are more suitable for internal use, since they give off the gas in a nascent form in the stomach.

SUMBUL.—Sumbul, U. S. P., or musk root, is the dried rhizome and root of *Ferula sumbul*, a plant of the family Umbelliferae, indigenous to the mountains between Russian Turkestan and Bokhara.

PREPARATIONS AND DOSES.—*Sumbul*, U. S. P. (the root). Dose, 15 to 60 grains (1 to 4 Gm.).

Extractum sumbul, U. S. P. (solid extract). Dose, 5 grains (0.3 Gm.).

Fluidextractum sumbul, U. S. P. (fluid-extract). Dose, 30 minims (2 c.c.).

PHYSIOLOGICAL ACTION.—Sumbul acts as a stimulant and antispasmodic. In small doses it stimulates the appetite and facilitates digestion. It is a stimulant to the nervous system, and also a tonic.

THERAPEUTIC USES.—Sumbul is employed as a tonic in **delirium tremens**, **hysteria**, **neurasthenia**, **chlorosis**, and **amenorrhea**. A resin prepared from sumbul is used to relieve chronic mucous discharges from the lungs (**bronchitis**), uterus (**leucorrhea**), and urethra (**gleet**). W.

SUNSTROKE. See HEAT EXHAUSTION.

SUPRARENAL CAPSULES, DISEASES OF. See ADRENALS, DISEASES OF.

SUPRARENAL ORGANO-THERAPY. See ANIMAL EXTRACTS.

SURGICAL ANAPLASTY, OR PLASTIC SURGERY.—Plastic surgery includes measures to correct

cleft palate, cicatricial deformities, etc., and to improve cosmetic appearances.

The common feature of plastic operations is the ready and secure union of refreshed or divided surfaces. The skin is the main factor of these operations, which are dependent upon its vascularity, elasticity, and mobility.

GENERAL CONSIDERATIONS.—In repairing defects, the neighboring skin can be employed by merely freshening the edges and suturing them together, making nearby incisions to relieve the tension (suture and tension), or by cutting more or less definite flaps and shoving them from one point to another (**gliding flaps**). A modification of the gliding flap with rotation is described by Croft, and may be called the "**granulation method**." It is especially useful in replacing scar-tissue left after burns. A flap large and thick enough is freed from its deeper parts (the deep fascia), but is left attached at both ends. A layer of rubber tissue or oiled silk is inserted between the raised flap and the deeper parts, and the under surface of the flap is allowed to granulate for from two to three weeks, when, one end being detached, the flap is rotated into the desired position and retained by sutures. Perfect asepsis is essential in and after the operation. Occasionally it is desirable to use flaps with pedicles (**pedunculated flaps**), obtaining them from the vicinity ("**Indian method**"), or from an extremity approximated and held fast till union has taken place ("**Italian method**"). Frequently the skin must be extensively undermined to increase its mobility.

The applications of plastic surgery are exceedingly numerous. A **crural ulcer**, for instance, may be covered by a pedunculated flap of the other leg, the **cuticle of the hand** may be replaced by flaps from the anterior or posterior surface of the trunk, the skin being sometimes elevated into a bridge and the hand slipped beneath (**pocket method**); defects in the **urethra** and **extrophy of the bladder** can be repaired with flaps from the scrotum etc.; neat plastic work is done in connection with **cleft palate** and **perineal repair**.

Double flaps are sometimes useful. For instance, if a single flap is turned from the neck into a total defect of the cheek,

the inner raw side will contract, causing deformity. This is avoided by using two flaps with their raw sides together: one from the neck and one from the scalp, the hair of the head simulating a beard. At times one permits two flaps to grow together before placing them in position; or the raw surface of a flap may be skin-grafted. Flaps may be bent upon themselves, rendering them thicker and supplying them with cuticle on both sides.

Flaps composed of skin and periosteum, with or without bone are cut and chiseled from adjacent parts and employed to fill defects in bone—*e.g.*, in the skull, or in osteomyelitis of the tibia. König employs, in **rhinoplastic work**, skin-periosteal-bone flaps obtained from the forehead. Occasionally one can chisel off a flake of bone through a small incision, and slide it from one spot to another by its loose areolar-tissue connections with the skin.

GENERAL TECHNIQUE.—The patient should be in good health, and the tissues free from disease and scarring. Flaps used should be thick and include the subcutaneous tissues, and their vascularity should be assured. Complete asepsis is of prime importance, suppuration increasing cicatricial contraction, and the cutting of sutures. Strong antiseptic solutions, especially bichloride, must be avoided, as they interfere with healing.

It may be preferable to cover defects by skin-grafts rather than to attempt extraordinary feats of plastic surgery.

Undue tension should be avoided, relaxation sutures often being useful. The sutures should be few, and be just tight enough to draw the parts together and no tighter. In cutting flaps, about one-third should be allowed for shrinkage.

Care must be used in twisting pedicles not to cut off the vascular supply. When possible, one should include a blood-vessel in the pedicle. The bruising of flaps must be avoided. A certain amount of pressure by the dressings is often advantageous, but it should not endanger the free circulation of fluids. Artificial warmth is, in general, unnecessary. Oozing must be carefully checked, preferably without the use of ligatures. An accumulation of blood beneath a flap may seriously jeopardize the success of an operation. Hairs may be

transplanted in flaps comprising the entire thickness of the skin, *e.g.*, in replacing portions of the **bearded cheek** from the scalp.

Puckers and irregularities following a plastic operation tend to disappear. This should be no excuse, however, for careless or unsightly surgery. Moderate discoloration of flaps, or the appearance of blisters, may mean superficial necrosis and not complete death of the flap. In plastic surgery dry dressings are generally preferable to moist ones. Pedicles should not be cut until definite healing has taken place and the circulation has become thoroughly established. This may require two or three weeks.

DEFORMITIES OF THE LIPS.

HARELIP.—This common congenital deformity is due to the non-union of the mesial nasal process with the superior maxillary process. The upper lip is usually affected. A frequent complication is alveolar or velopalatine fissure.

Varieties.—**Median harelip** is rare, varying in degree from a slight indentation in the vermillion border of the lip to a complete division reaching upward into the nasal septum; the frenum in this case is also split. A bilateral cleft, with the middle of the lip and maxilla absent, may be mistaken for a median cleft.

Simple Unilateral Harelip.—This varies from a notch in the mucosa to a cleft which divides the nostril. On the cutaneous aspect of the lip the mucosa is generally everted. In the more extensive forms there is usually atrophy of the external border of the cleft, the nostril is widened, and the ala nasi lowered.

Unilateral Harelip with Fissure of the Bony Parts.—In this form there is added a cleft in the alveolar arch, with or without irregularities of the teeth.

Simple Bilateral Harelip.—Here there is a cleft on both sides.

Complicated Bilateral Harelip.—In these cases there may be simple alveolar fissure on one side and a complete cleft on the opposite side. Usually symmetry marks those deformities, and the bony lesions are: an alveolar fissure of both sides, with slight protuberance of the maxilla; a deep fissure extending between the margins of the bony gaps, the nasal and buccal mu-

cosa being intact; a complete fissure through the mucosa and bones, terminating at the anterior palatine foramen by two lines converging anteroposteriorly; and finally with palatine roof nearly always divided. Other deformities of the face are at times present, such as congenital fissure of the cheek, eyelid, etc.

Single harelip occurs most frequently on the left side (75 per cent.). It is often traceable to heredity.

Treatment.—A fixed age at which operation should be done—the sixth week, the third month, etc.—cannot be applied to all cases. While one could easily stand operation a few weeks after birth, another would die from shock. In the simpler cases the earlier the operation the better. Should the child be weakly, or the fissure be double and extend through the hard parts, the operation should be postponed until the second or the beginning of the third year.

The following general technique is that recommended by Shepherd: For children under 1 year an anæsthetic is dangerous; for those older, chloroform is the best anæsthetic. The child should be confined in a sheet or large towel, and held in the arms of a strong nurse, the head being steadied by an assistant, who thrusts the head a little forward to prevent the blood entering the mouth. Sitting in front, the operator should first cut through the mucous membrane attaching the lip to the gum, and freely separate it so that the lips hang loosely. The edges of the cleft are then freely pared by using a narrow-bladed knife and transfixing the edge of the cleft well up to the nostril; the flap is cut free above, but below is left on each side attached to the edge. As the two edges of the cleft are seldom of the same length, on the longer side the soft parts should be more freely freshened. Both flaps should be cut as far as the red line of the lips. Any redundancy can be cut off. The flaps should not be separated from the edges of the cleft below until several sutures have been placed in the lip above and the fastened edges of the cleft accurately adjusted near the nose. The paring from the shorter side is then cut away, and more or less, as occasion requires, of the tissue at the red portion of

the lip removed; the flap of the long side is then brought over and adjusted. During operation an assistant compresses the sides of the cleft with his fingers. Should blood get into the mouth, it is at once removed. Silkworm gut and horsehair sutures are employed. Care should be taken not to go through the lip while suturing, but to dip down to the mucous membrane only; the stitches should range on each side at least one-eighth of an inch from the edge. If the sutures seem to pull too much, or if there is a slight unevenness, one should immediately take them out and reintroduce them. After the main sutures of silkworm gut are placed, intermediate ones of horsehair may be used, the lip then everted, and the mucosa sutured. Important points in operating are: (1) Freeing the lip from the gum. (2) A free sacrifice of the edge of the cleft. (3) Accurate apposition of the parts.

In dressing, an antiseptic paint (iodoform, resin, oil, and alcohol) applied over, a piece of lint or cotton is used. Cheek-straps to prevent tension are made of diachylon plaster, and the cheek parts cut broader than the part running across the lip; they should interlace in the mid-line.

Before operation it is very important to know that the child has not been exposed to any fever, measles, or scarlatina. Other causes of failure are inordinate crying, too early removal of the stitches, and especially infection. Silkworm gut is left in from six to ten days. Should primary union not occur, one should wait until the inflammatory action has subsided, then freshen the edges and bring them together.

It is well to introduce a prophylactic suture before freshening the edges of the cleft so that as soon as dissection is ended the raw surfaces are brought together and bleeding suppressed.

After-treatment and Complications.—Firm union takes place early if the wound is aseptic. Every alternate superficial stitch may usually be removed on the second or third day. The deeper sutures should remain six days. The child's hands and arms should be restrained, and patient prevented from turning on its face

and rubbing the lip on the pillow. Liquid nourishment may be given three or four hours after the operation.

Complications may usually be traced to a weak condition of the patient or to sepsis; death, if it occurs, is usually due to low vitality; wound infection rarely endangers life, unless bone infection occurs. In apparent failure, remove sutures and

After the operation there is often great difficulty in breathing through the nostrils, and intranasal rubber tubes or portions of a large-sized catheter introduced are often an aid. These may be withdrawn after twenty-four hours.

In **simple unilateral harelip**, where there is only a notch in the mucosa, **Nélaton's operation** is advised. An inverted V-



Nélaton Operation for Incomplete Harelip.
Line of incision.



Incision Converted into a Perpendicular One.
Ready for suture.

apply wet dressings, and allow healing to proceed by granulation. The danger of pneumonia and bronchitis may be diminished by preventing blood and mucus from entering the trachea with the **Trendelenburg position**, or holding the child upright with head inclined forward. The effects of hemorrhage and shock may be combated with copious saline hypodermoclysis.

shaped incision is made through the lip, around the corner of the notch and parallel with its edges. The incision is converted into a vertical one and its edges are united with interrupted sutures.

In **unilateral harelip with fissure of the bony parts (alveolar process)** and advancement of the intermaxillary bone the latter is not only misplaced, but usually



Hagedorn Operation for Complete Double Harelip.
Paring and formation of flaps.



Parts Ready for Suture.

Jacobson calls attention to an infrequent, fatal complication: When the cleft is large and the upper lip when restored is tight, when it overhangs the lower, if the nostrils are flattened and partially closed by the operation, owing to tension of the parts, the breathing space may be so limited that temporary interference with respiration may occur. In these cases, Rose suggests that the nurse depress the patient's tongue at intervals, or a strip of collodion be painted from lower lip to chin to hold the lip open.

rotated, so as to present a prominent sharp edge anteriorly. It should be twisted upon its long axis and set square, so that its sharp lateral edge will not project under the line of sutures. It may be necessary to forcibly separate (with bone forceps or chisel) the bony process from its alveolar attachment, and bring it in place by rotating it upon its long axis. If the vomer prevents, the edge of the intermaxillary may be resected with a chisel or rongeur, in which case we lose an incisor tooth. As these measures complicate the operation,

the latter should be deferred in very young children. Finally, the cleft in the lip may be closed by the method already mentioned.

In **simple bilateral harelip**, the double **Malgaigne** or double **Hagedorn** operation may be applied. The middle segment is invariably too short to form a part of the free border of the lip, but may be utilized to form the middle portion. One side may be done at a sitting, or the lateral margins of the middle segment and the corresponding margins of the lateral segments may be freshened and united, thus converting it into a double incomplete harelip, to be corrected later. If the nose is flattened, the lateral segments of the lips and the sides of the nose should be separated from their deep attachments.

In **complicated bilateral harelip**, the projecting premaxillary prominence may be replaced by simple fracture or by excising a wedge (Blandin) or quadrilateral area from the nasal septum. The middle segment may be placed very far forward, upon or near the tip of the nose; here the cutaneous part of the nasal septum is absent and the soft parts must be made into the tegumentary part of the nasal septum, and the whole lip must be formed from the two lateral segments alone. Liberation of the flaps may be necessary, by separating them from the alveolar process of the superior maxilla, or, in addition, an incision may be necessary upon either side, around the ala of the nose, known as **Dieffenbach's Wellenschnitt**. As a rule, the attempt to replace the middle segment should be made during the first, second, or third year. If the intermaxillary bone is entirely excised the four incisor teeth are lost, and a plate must be fitted. If it is simply replaced, it usually remains rudimentary and the attached teeth imperfect. Removal of any considerable part of the septum, in order to replace the intermaxillary portion in its normal position, will cause the tip of the nose to be flattened downward.

HYPERTROPHY OF THE LIPS.—

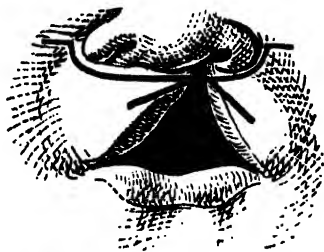
This may be observed in healthy individuals, but more frequently in strumous children. When it disfigures the patient, the deformity is usually corrected by removing an elliptical piece of the mucous

membrane and submucous tissue in a horizontal direction. Tissue removed should represent the excess only, lest there result undue recession.

DEFORMITIES DUE TO INJURY.

—Burns and scalds are the most prolific causes of labial deformities, ectropion or eversion of the lip being caused. The lower lip is usually that involved, and the exposure of the teeth and gums, the interference with speech, and dribbling produce a repulsive appearance, especially when the injury involves the tissues of the chin and neck; the lip may then be drawn over the chin and the latter to the interclavicular notch or even the sternum.

Treatment.—The method recommended by Mr. Teale, of Leeds, is as follows:



Wellenschnitt for Complete Harelip. Incision carried around the alæ of the nose in order to liberate the segments. Formation of flaps by incision into each segment.

"The everted lip is divided into three parts by two vertical incisions three-fourths of an inch long and carried down to the bone. These incisions are so planned that the middle portion between them occupies one-half of the lip. From the inner end of each incision the knife is carried upward to a point one inch beyond the angle of the mouth. The two flaps thus marked out are freely and deeply dissected up. The lateral flaps are now raised and united by twisted sutures in the mesial line and supported, as on a base, by the middle flap, to which they are also attached by a few points of suture, leaving a triangular even surface to granulate." This operation usually gives good results, but it must sometimes be slightly modified to suit existing conditions.

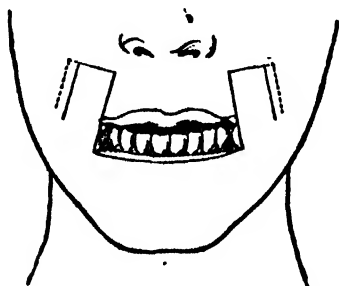
EVERTED LIP.—Where eversion is in the median line, above or below, a single

incision at right angles to the free margin of the lip in the median line may be made. This is converted into an incision lying parallel to the free margin of the lip; sufficient inversion results to improve the appearance. This incision is made from the labiogingival junction to the inner margin of the exposed portion of the lip. A long lip may be shortened by passing the first sutures in the median line so that it is fixed on the connective tissue overlying the gum; the degree of tightness with which this suture is tied will measure the shortening.

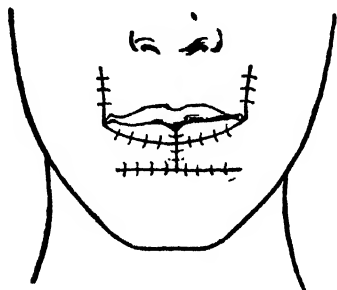
Where the entire lip is everted, the incisions are multiple. A portion of the

sia with scissors. When it has progressed beyond this stage, all related lymphatic glands in their typical position must be removed. If the glands are not perceptibly enlarged, they are taken out with the surrounding fat, before the tumor; this sequence is important. As a rule, the incision should be carried two-fifths of an inch wide of all obviously affected tissue. There were only 3 cases of local recurrence out of 113 operations in which this rule was followed.

When the edges of the new lip are devoid of mucous membrane, the mucosa may sometimes be pulled over the defect from within and stitched to the skin. A



Bruns Method of Restoring the Lower Lip. Dotted lines indicate that the mucous membrane is cut longer than the skin in order to provide a mucous membrane border to the new lip.



Flaps Turned Down and Joined to Form New Lip. Mucous membrane is sutured over the free margin of the new lip. The defect upon each side of the cheek is closed by suture.

mucosa may be excised, but the incision should be well inside the mouth. The portion showing as a "double lip" should never be excised.

INVERTED LIP.—The operation is the reverse of the preceding.

EXCISION OF LABIAL CANCERS.—

A V-incision, including the mass and closed with deep silkworm-gut sutures, is, as a rule, alone required. The wound usually heals in a week. The resulting small, rounded, puckered opening, representing the mouth, which is formed entirely by the upper lip, regains a nearly normal appearance after from six to eight months. When the growth has progressed farther, all diseased tissues—always including all enlarged glands—should be removed.

Fricke urges that every ulcerating wart about the lips which resists treatment should be extirpated under local anesthe-

sia with scissors. When it has progressed beyond this stage, all related lymphatic glands in their typical position must be removed. If the glands are not perceptibly enlarged, they are taken out with the surrounding fat, before the tumor; this sequence is important. As a rule, the incision should be carried two-fifths of an inch wide of all obviously affected tissue. There were only 3 cases of local recurrence out of 113 operations in which this rule was followed.

FORMATION OF THE LOWER LIP AFTER COMPLETE EXCISION.—To remedy a triangular defect too large for simple suture the **Dieffenbach-Jäscbe method** may be used. An incision, from each corner of the mouth, is carried outward and somewhat upward into the cheek for a distance sufficient to close the defect in the lip, allowing one-third for shrinkage. A second curved incision, from the end of each of these incisions, is then carried downward and inward toward the chin, terminating near the lower border of the jaw and under the angle of the mouth. Stenson's duct is avoided. The mucosa, corresponding to that part of the incision that passes outward from the corners of the mouth, should be cut upon a higher level than the skin to

form the free border of the new lower lip. At all other points the incision goes through on the same level. The two flaps are now separated from the lower jaw, avoiding injury to the fold of mucous membrane reflected to the gums. The edges of the gums are united with interrupted silk sutures through the lip down to the mucosa. The edges of the mucous flaps, which were cut long, are turned outward and sutured to the skin. The semilunar defects on either side are closed with sutures.

For a quadrangular defect the **Brun's method** may be used. A square-cornered flap, from either side of the face, through the whole thickness of the cheek, is turned down through an angle of ninety degrees. The apposed edges of the flaps are united and the mucous membrane sutured to the edge of the skin to form the free margin of the new lip, and the lateral defect on either cheek is then closed.

As large a defect as that left after excision of three-fourths of the lower lip may be replaced by **Estländer's method**.

RESTORATION OF THE UPPER LIP.—A defect may be closed by **Estländer's method**, the lower lip furnishing the flap. In **Dieffenbach's Wellenschnitt** a curved incision is made through the whole thickness of the cheek around the corner of the nose. The flaps thus marked out are separated from the maxillæ, drawn toward the middle line, and turned down, so that the raw edges of the original defect form the free border of the new lip. The two flaps are united and the edges of the mucous membrane and skin sutured along the free margin of the new lip. The mucosa may be cut a little longer than the skin to facilitate the union of these edges. The defects around the side of the nose may be sutured together after the flaps have been united in the middle line. Small wedge-shaped defects may be closed with **sutures**, combining this, if necessary, with detachment of the cheek by **Dieffenbach's Wellenschnitt**.

MACROSTOMA (LARGE MOUTH).—This is a deformity of the mouth due to failure of the maxillary process to unite with the mandibular process during development. The mouth may be prolonged on one side so as almost to reach

the ear. The condition is often associated with malformation of the auricle.

Treatment.—The edges of the buccal opening may be freshened and united, leaving enough of the aperture to constitute a normal mouth. The latter must not be made too small, however, the patient having to undergo a gradual training in the use of the lips in speaking, drinking, etc. In some cases a plastic operation is required.

MICROSTOMA (CONGENITAL ATRESIA ORIS).—This is the result of an excessive degree of fusion between the maxillary and mandibular processes, and may be marked. It must be differentiated from acquired stenosis, from cicatricial contraction after burns, syphilitic ulceration, lupus, etc.

Treatment.—The mouth is enlarged by incising the cheek at the angles of the mouth and suturing the mucosa to the skin.

CLEFT PALATE.—This condition is the result of imperfect union, during fetal life, of the two horizontal septa which, by their growth, form the partition between the nasal cavities and the mouth. When the posterior portions of the processes fail to coalesce, the resulting triangular slit forms the "cleft."

It varies from bifid uvula to complete central division of the soft and hard palates. In many cases of the latter kind the margin of one of the maxillary processes is fused with the vomer. It may be associated with harelip on one or both sides, the intermaxillary portion, in the latter case, carrying two or three incisors.

The cleft interferes with voice-production, owing to the escape of air into the nasal cavities, and with deglutition, food being forced into the postnasal space. During infancy this may be dangerous, the infant being unable to suck satisfactorily, owing to the inability of the soft palate to close off the naso-oral isthmus.

Treatment.—The time to operate depends upon the condition of the child, the extent of the deformity, and the degree of interference with normal feeding. In inextensive clefts the child soon adjusts the oral tissues and finally swallows sufficient food; but an early operation is

indicated to avoid imperfect enunciation when he begins to speak. In England it is customary to operate about the fifth or sixth year; in America about the third.

When interference with deglutition is marked, Mansell-Moullin recommends that a flap be adjusted to the rubber nipple so disposed as to close the cleft, or if the nipple be long that the opening be on its under surface. If a soft-palate cleft is closed before speech is learned, the result, so far as the child is concerned, is perfect. Closure should, therefore, occur somewhere between birth and the end of the second year; within this age limit the later the operation is performed the better. When there is a complete cleft, both of the lip and the palate, Murray advises operation on the lip when about three weeks old, leaving the palate alone until the end of the second year. Lip closure influences the subsequent growth of the hard palate. Where the hard palate is involved articulation will always be somewhat defective.

Staphylorraphy.—This operation is a somewhat tedious performance. The Rose position is most satisfactory, the child on its back lying on a hard mattress, wrapped firmly in a sheet, and with a firm pillow underneath the shoulders. The head must be toward the light, extended, and project a few inches beyond the table. The mouth is kept open by means of a mouth-gag. Both sides of the soft palate are, in turn, seized with a tenaculum forceps and their edges pared off with a very sharp probe-pointed bistoury. Curved needles are used for sutures, the best of which is silk-worm gut. Some surgeons prefer silver wire and use tubular needles. The needle is introduced on either side from below, the sutures being made double on one side and single on the other. The latter being passed through the former, the stitches are tied, after the pared edges have been carefully brought in apposition. If the parts are not under tension, the operation proper is finished; if they are, a procedure introduced by J. Mason Warren should be resorted to: *i.e.*, the levator and tensor palati muscles should be divided by pushing a tenotomy knife through the soft palate, immediately internal to the hamular process and cutting upward until the muscles are severed. The brisk hemor-

rhage soon stops. The head may be turned to one side and the mouth swabbed out with ice-water. Blood should not be allowed to trickle into the larynx.

Finally the parts should be carefully irrigated with **boric acid solution**. Only **tepid and liquid food** should be allowed the first few days and **soft food** subsequently until adhesion is complete. This occurs in a healthy child at the end of a week, when the stitches may be removed, but it is better and often necessary to leave them longer. When a small portion of the wound fails to heal, it should be stimulated with the **mitigated stick**.

Polaillon performs staphylorraphy in two sittings, at an interval of twenty-four to forty-eight hours. At the first sitting lateral incisions are made; the mucosa is dissected from each side and loosened from the palatal bones; then hemorrhage is arrested. At the second sitting, the edges of the tissues are vivified and very fine sutures introduced. This operation may be done under cocaine anesthesia.

Owen detaches the mucoperiosteum from the back of the hard palate, in order to gain a slackness of tissue at the anterior part of the cleft in the velum. Tension is further diminished by lateral incisions passing through the soft palate parallel to the line of the sutures.

Uranoplasty.—If, in a case, the hard palate alone is fissured, the old procedure advised by J. Mason Warren is still resorted to by most surgeons. It consists in carefully separating the mucous membrane and periosteum from the bone on both sides with the palate elevator, beginning at the margin of the cleft and extending on each side toward the alveolar process as far as needed. The vessels in the palatine canals must be avoided. The free flaps of membrane thus obtained are then brought together over the opening and sutured. When the soft palate is also cleft, it should be cut from the horizontal edge of the hard palate and the edges of the fissures pared and united precisely as in staphylorraphy, including the section of the palatal muscles if required. Sutures are then introduced, the first being inserted at the junction of the hard and soft palate after the flaps have been carefully adjusted. In cases where the fissure

is not wide, the separation of the soft palate from the hard palate is not required; both edges of the entire fissure are pared, the membrane over the hard palate is raised, and the entire opening is closed by approximating the pared edges and suturing them. Subsequent measures are as in staphylorrhaphy.

Ferguson divides the bone on either side of the fissure and forces each fragment thus obtained toward the median line. The edges of the fissure are first freshened; holes are drilled through the bony processes near the edge and silver sutures are passed through the openings; a strip of bone is then cut off with a chisel or saw from each side and pressed over to the median line. The sutures are then drawn together and tied. Division of the soft palate downward is necessary. This operation has not obtained much favor, though it is a satisfactory one.

Berry and Legg divide their operation into five parts:—

- (1) Detachment of the mucoperiosteal tissues of the palate from the bony palate;
- (2) Detachment of the soft palate from the posterior edge of the palate bones;
- (3) Paring the margins of the cleft;
- (4) Suturing the pared edges;
- (5) Making, if necessary, lateral incisions to relieve tension.

Arbuthnot Lane uses the flap formation to close in the hard and soft palates by two methods: "If the soft parts overlying the edges of the cleft are thick and vascular, a flap is cut from the mucous membrane, submucous tissue and periosteum of one side, having its attachment or base along the free margin of the cleft. The palatine vascular supply is divided when the flap is being reflected inward, and it derives its blood-supply from vessels entering its attached margin. The mucous membrane, submucous tissue and periosteum are raised from the opposing margin of the cleft by an elevator, an incision being made along the length of the edge of the cleft. The reflected flap, with its scanty supply of blood derived from small vessels in its attached margin, is then placed beneath the elevated flap, the blood-supply of which is ample, and it is fixed in position by a double row of sutures. In this way two extensive, raw

surfaces, well supplied with blood, and uninfluenced by any tension whatever, are retained in accurate apposition. If, on the other hand, the cleft is too broad to admit of its safe and perfect closure in this manner, one flap, comprising all the mucous membrane, submucous tissue, and periosteum on one side, is raised, except at the point of entry of the posterior palatine vessels, while the soft parts on the opposite side are raised in a flap from which the posterior palatine supply has been excluded, and which turns on a base formed by the margin of the cleft. Here is a mobile, well-vascularized flap, which can be thrown as a bridge in any direction, and can be superimposed on the flap of the opposite side, the closure being necessarily rendered complete by flaps from the edges of a harelip."

A feature of these operations is that much hemorrhage usually occurs. This can be, in part, prevented, however, by pressing upon the tissues behind the upper incisors. The descending palatine arteries can be plugged with a match-stick.

Jacobson and Berry operate not earlier than the second or the beginning of the third year for the following reasons: The parts are larger, more easily manipulated, and do not tear so easily; hemorrhage is more easily controlled and better withstood; congenitally deformed children do not bear operations well; the postoperative care is easier and more satisfactory; the liability to postoperative pulmonary infection, convulsions, and diarrhea is minimized.

John B. Roberts advises operation when the infant is only a few days old, except in case of grave physical disability, when the operation may be delayed a few weeks, during which time digital compression is applied daily. Squeezing the separated segments of the hard palate together a few dozen times every morning and evening, he claims, will tend to lessen the breadth of the cleft and favor the formation of a bony roof to the mouth by operation.

After-treatment.—The oral cavity should be sprayed daily with a mild alkaline antiseptic lotion. The wound should not be inspected unless the child struggles and cries. During the first week liquid nourishment, in small quantities at

a time, should be given, using a spoon. To prevent the baby from crying, it should be nursed and soothed; if the child is older, it should be forbidden to talk. Not earlier than the tenth day the stitches may be removed, the patient being anesthetized. The crucial test of success is improvement in speech. Elocution lessons should be given later to this end. Three months after the operation the wound should be re-examined, and if the soft palate appears overtense, the mother or nurse should massage the parts.

In some cases operative procedures cannot be resorted to; obturators constructed by dentists should then be tried.

RHINOPLASTY.—Plastic operations are often indicated for deformities of the nose from syphilis, lupus, or traumatism.

Indian Method.—In this procedure a pear-shaped flap, somewhat larger than needed to make up the soft tissues necessary, is mapped out on the forehead. The nasal edges are thereupon carefully freshened and leveled, a regular bed being prepared for the flap. The latter is carefully detached with the periosteum from the frontal bone, twisted down, and so adjusted as to cause a bend in the flap to correspond with what would represent a nasal bridge. Two hard-rubber tubes shaped like the anterior nares should be inserted and the flap sutured in place.

Schimmelbusch resorts to the following operation: A three-cornered skin-and-bone flap is taken from the middle of the forehead. This flap is so cut out with the knife that the smaller base is at the root of the nose, and the broader side lies exactly in the middle of the forehead. With a sharp, broad chisel the anterior surface of the frontal bone represented by the flap is chiseled off. From the angles of the forehead defect, large, arched incisions are carried over the skull toward the ears, and the flaps loosened and sutured over the forehead. In this manner simple linear scars remain in the forehead. The loosened flap must first be allowed to granulate, and then it is transplanted upon the wound surface. The bone plate is sawed along its middle line and folded together in the form of the nose. This formed flap is then sutured into the freshened wound in such a way that the raw

surface stands posteriorly and the skin surface anteriorly. The septum of the nose is simply obtained from the skin in the deformed nose; so that strips of skin are taken from the sides of the defect as far as the natural position of the septum. The tip of the nose is also formed from the original nose. The first week a silver wire with buttons on either end is passed through the nose at the level of the alæ, and left in place until the separation of the forehead flap. This helps form the alæ by its lateral pressure.

Transplantation of a piece of **bone from the tibia** for nasal deformity is preferred by the writer to that of the rib. A curvilinear incision is made between the eye-brows, with the convexity downward. The periosteum is next cut higher up than the skin incision and loosened above, then turned back from the nose on the bridge below. The skin is dissected over the nose by means of Freer's septal dissectors and a piece of tibial bone inserted under the skin to the tip of the nose and the upper end inserted under the upper portion of the periosteum of the forehead. Stauffer (*Penna. Med. Jour.*, 21, 26, 1917).

Italian Method.—A flap is taken from the arm of the patient, over the biceps, at a spot corresponding with the nose when the hand is applied over the head from the front. The flap is so shaped as to assume that of the nose when *in situ*, allowing $\frac{3}{8}$ for shrinkage. A pedicle from the arm is preserved to insure nutrition. The flap is left thus about two weeks, to enable it to become vascular and covered with granulations underneath. At the end of this time the nasal orifice is prepared as for the Indian method; the forearm is placed over the head and fastened there by bandages, and the flap is adjusted to the pared nasal edges and sutured. The patient must remain in this trying position about twelve days, when the pedicle is cut and the arm released. The pedicle is then trimmed and a column is either formed with it or with a small flap taken from the upper lip. The procedure is often successful, but it is irksome, and a presentable nose is seldom obtained.

In less marked deformities, usually of

the alæ, a small flap may be obtained from the cheek or forehead. A pedicle should always be left to insure nutrition of the flap. If the redundant portion is unsightly, it may be adjusted as soon as the nasal flap is thoroughly nourished through its new channels. (See SKIN-GRAFTING.)

REDUCTION OF HUMP-NOSE (AQUILINE NOSE).

—Charles C. Miller suggests an operation done under infiltrative anesthesia. The nares are thoroughly cleansed with gauze strips wet with a mild antiseptic or soap solution. The line of incision is along the free margin of the nasal bone and need not be long (one-quarter inch), as a very narrow chisel serves best for loosening the hump. Care should be taken not to chisel beneath the nasal bones, but beneath the hump, and when it is entirely free except for the overlying periosteum, the loosened fragments are grasped with small forceps, passed upward, and peeled from the periosteum. Entire dependence is placed upon an elevation of the nasal tip to give access to the hump. Any remaining irregularity felt should be smoothed with chisel or cutting rasp. Bleeding may be free, but is soon controlled by pressure.

STENOSIS OF THE NOSE.—In partial stenosis an incision is made in the median line of the nostril, carrying it backward when the stenosis is posterior, and forward when the stenosis is toward the nasal tip. After complete division the tissues are everted and excess trimmed off with scissors, so that the skin alone is left. Two skin flaps are thus formed which are turned upward into the nose and sutured with fine silk. Small curved needles serve best.

Complete stenosis is treated in a similar manner, unless distortion exists.

PARAFFIN INJECTIONS (HYDRO-CARBON PROTHESIS).—The judicious use of paraffin is allowable in special cases. Unless, however, the most perfect asepsis is maintained, infection is apt to follow; a marked redness of the skin with irritation of surrounding tissues may lead to abscess and tissue necrosis. Necrosis may also be caused by the pressure of the injected mass on blood-vessels or by excessive heat of the mass. Embolism is apt to follow accidental injection into a

vein. Overcorrection of the deformity may follow an excessive amount injected. Unless the melting point is above the body temperature, absorption is likely to occur.

The injection is made with a special syringe, strong, with a screw on the piston to allow a measured quantity of the semi-solid mass to be forced slowly into the tissues, able to resist the heat of sterilization and with a lumen large in proportion to the size of the needle.

The paraffin mass consists of 1 part paraffin to 8 parts of white vaselin; the melting point of the mixture should be between 105° and 110° F. (40.5°—43.3° C.). The paraffin should flow from the needle in a solid, worm-like stream. Care must be taken that the flow has ceased before withdrawing the needle. A drop of collodion will seal the puncture.

In raising the nasal depression of a **saddle-nose**, the needle should be inserted quickly and the paraffin forced into the subcutaneous tissue steadily. If the needle becomes plugged the paraffin may be deposited into the forehead or into loose tissue on either side of the root of the nose. The paraffin should be so molded as to form a narrow bridge. When the paraffin solidifies, molding is impossible.

These injections have been successfully used to fill out **hollow cheeks**, and to fill the interval between the **brows** when the location was unusually low and marked by perpendicular lines.

PLASTIC SURGERY OF THE EAR (OTOPLASTY).

OUTSTANDING EARS.—Much can be done in early childhood to prevent this condition. Where a tendency to it exists the parents should be induced, if possible, to adjust a bandage which shall hold the ears firmly against the side of the head. This bandage may be worn at night, and if persisted in will, in most cases, correct the condition. In adult life, when the cartilages are formed, this plan is not so feasible.

Operations may be performed under infiltration anesthesia. The solution used is boiled water, or, better, normal salt solution in each ounce (30 c.c.), of which $\frac{1}{4}$ to $\frac{1}{2}$ grain (0.015 to 0.03 Gm.) of cocaine is dissolved. This is injected along

the line of juncture of the ear with the cranium posteriorly. After the tissues are infiltrated they are divided along this line, and a crescentic flap of the skin is dissected off on both sides. In slight cases the ear may be now held in its corrected position by closely suturing the skin margins. When the ear resists correction and there is tension on the sutures the cartilages of the ear may be divided with a small knife through the posterior incision. In more extreme cases a wedge-shaped portion of the cartilage may be removed, care being exercised so as not to puncture the skin anteriorly. Kolle outlines the flap to be removed from the back of the ear with the point of the knife, then presses the ear against the cranium, and so has the outline of the cranial flap accurately made.

ABNORMALLY ENLARGED EAR (MACROTIA).—This deformity may be corrected by either the Kolle method or the Parkhill method, or if the ear is excessively large, a triangular section may be removed and the parts sutured. Another plan is to remove a crescent of tissues combined with a small strip from the outer margin or helix.

REPAIR OF CLEFTS AND FISSURE OF THE LOBULE.—The most common form is that produced by the tearing out of an earring. The wounded part should be cleansed, any lacerated shreds of tissue removed with scissors, and the parts sutured with catgut or silk. When seen later, both sides of the cleft are infiltrated, the margins denuded with scissors or scalpel, and the parts sutured.

ENLARGED LOBULE.—This may be corrected by first infiltrating the parts, then, if the lobule is enlarged in all directions, operating by Joseph's method. The incision should be carefully mapped out before it is made, particularly if both ears are deformed.

ELONGATED LOBULE.—If the lobule is too long a vertical incision is made parallel to the long axis of the lobule, and after removing any excess of tissue the line of incision is sutured in the direction opposite to the original one, thus shortening and broadening the lobule.

SHORTENED LOBULE.—The preceding operation is reversed.

ADHERENT AND UNDEVELOPED LOBULE.—Where the lobule is nearly normal and is merely attached by a fold of skin, this fold may be divided, the skin edges of the lobule united with sutures, and the edges of cranial skin likewise.

Where the lobule is not well formed but triangular in shape, it should be cut free internally, and a small flap formed along the outer margin of the lobule, the lobule being trimmed into shape and the small flap adjusted around it.

For the correction of protruding, roll, or dog ears the writer cuts an ellipse of skin from the back of the ear and the neighboring mastoid with the superficial fascia, care being taken to expose the periosteum and perichondrium, which are stitched together with chromic catgut. G. Selfridge (Calif. St. Jour. of Med., Sept., 1918). S. and W.

SWAMP FEVER. See **MALARIAL FEVERS.**

SWEAT-GLANDS, DISEASES OF THE.—Although apparently insignificant, disorders of the sweat are often a source of considerable distress. **Sudamina**, treated in the sixth volume, page 705, as a separate article, owing to its importance in general febrile diseases, is one of these; but there are, besides, functional disorders, which merit special attention owing to the frequency with which some of them occur in practice.

ANHIDROSIS, or deficiency of perspiration, may be physiological in the sense that some subjects never perspire perceptibly. As a rule, however, it is a symptom of some general disorder such as diabetes and certain fevers; or of some cutaneous diseases such as psoriasis, ichthyosis, squamous eczema, etc., the affected areas failing to sweat when the lesions are sufficiently developed. Various neuroses also include deficient activity of the sweat-glands as symptom. Hence the localized areas showing this defect and its incidence with scleroderma. Anhidrosis may also be congenital.

Treatment.—When anhidrosis can in any way be connected with asthenia of vascular or nervous origin, the underlying

cause should be ascertained and removed. In addition to this, stimulation of the sweat-glands by means of **pilocarpine**, along with vascular tonics such as **nuxvomica**, **strychnine** and also well-regulated **exercise** in the open-air and **bathing** followed by **light massage** are often productive of good results. The anhidrosis accompanying cutaneous diseases is met by measures addressed to the latter.

HYPERIDROSIS, OR EXCESSIVE SWEATING, also termed **ephidrosis**, **polydrosis**, and **sudatoria**, is a functional disorder of the sweat-glands due to defective sympathetic or cerebrocentral innervation. It may be physiological under the influence of heat, excitement or fear, or occur as a result of overexertion. It becomes pathological when it occurs in the course of diseases such as pulmonary tuberculosis, rheumatism, malaria, the anemias, etc.; it is referred to under these respective headings. The present article will include only localized sweating as it occurs in the axillæ, upon the soles and palms, genitalia, face, etc. Occasionally, the hyperidrosis is unilateral and may affect the half of the forehead and face—often with migraine in the corresponding area—and, as in paraplegia, the whole body.

While in some cases even localized hyperidrosis may be constant, it is, as a rule, exaggerated by heat or warm weather, particularly where the parts are covered. Here, especially about the genitalia and in the axillæ, **intertrigo** may develop. Sweating palms are usually cold and clammy, though the sweat produced in some cases is such as to fill up the hollow of the upturned hand and to run over the edge. The axillæ and where the breasts are large enough to come into contact are often the seat of hyperidrosis. Sweating of the face is most marked about the forehead, eyelids, and nose; the scalp is not infrequently the seat of hemidrosis, which often leads in this region to loss of hair. Hyperidrosis of the feet is particularly annoying, since it is frequently accompanied by fetor—a condition studied specifically below under Bromidrosis. The soles may become sodden and macerated and the skin between the toes likewise, the feet being thus rendered tender—suffi-

ciently so in some cases to interfere with walking.

Treatment.—The patient's general condition should be carefully inquired into and any disorder discovered corrected if possible. The nerve centers governing the sudatory function should then be toned up by means of agents known to influence them, viz., **atropine**, **agaricin**, **ergotin**, or **pilocarpine**, the latter in small doses. **Warm** followed by **cold douches** and **static baths** are very useful to promote the activity of the sweat-glands where, as in obese and debilitated subjects, undue patency of their tubuli underlies the disorder. When on the hand there is undue activity of the glands, as in hysterical subjects, **bromides** and **valerates** are indicated. In some cases a deficiency in calcium underlies the trouble; **calcium phosphate** is the most efficient agent to meet this demand. **Sulphur** is often productive of good results, a teaspoonful of precipitated sulphur being given in milk twice daily, and once daily if too active.

For hyperidrosis of the axillæ, hands, or feet, local baths with **vinegar**, an infusion of **walnut-leaves** and **alum**, a quarter of 1 per cent. solution of **potassium permanganate**, or a mixture of a tablespoonful of commercial **formol** in a quart of water, are all effective. Subsequently the affected parts should be bathed with the following lotion, diluted with one or two parts of water:—

℞ *Naphthol B.* 5 parts.
Glycerin 10 parts.
Alcohol 100 parts.

M. For a lotion. To be diluted.

Or the following may be used:—

℞ *Thymol* gr. xv (1 Gm.).
Tannin gr. lxxv (5 Gm.).
Spirit of camphor. ℥vij (210 Gm.).

M. Lotion. To be applied over sensitive area with a brush or cotton wad.

Subsequently the feet should be carefully dried, and powdered with **talcum**, **starch**, or **bismuth subnitrate**, or preferably with the following:—

℞ *Salicylic acid* 3j (4 Gm.).
Starch 3iij (12 Gm.).
Powdered talc .. 3iij (100 Gm.).

Mix thoroughly. Foot powder.

Another efficient powder for the feet is the following:—

℞ *Bismuth subnitrate* ʒj (31 Gm.).
Sodium salicylate. ʒiiss (10 Gm.).

Mix thoroughly. This powder may be dusted into the socks and shoes.

The X-rays have been used by a number of observers with encouraging results.

The writer noticed that after a long-continued series of sittings under X-rays the patient ceased to perspire on the part treated. Since that time he has had 20 cases of excessive perspiration to treat. Nine of these have been qualified medical men. In every case which has been fully treated the rays have produced their effect on the sweat-glands, and either entirely stopped their action or reduced it to less than normal. In 2 cases which were cured by 2 sittings, both suffered from the effects of too large a dose of X-rays (pain, irritation, blistering, and redness); since then all others have been done by the longer method. Six sittings, of one pastille dose each, at intervals of one month, give the best results, and cause no discomfort. Pirrie (*Archives of Röntgenology*, Feb., 1912).

BROMIDROSIS.—This condition, also termed **fetid sweating** and **osmidrosis**, is characterized by a more or less strong odor of the sweat. It may be general, as in the negro; but often, as is the case in some red-haired subjects, it is restricted to the axillæ and feet. When limited to the latter, bromidrosis is vulgarly known as **stinking feet** and is a source of profound mortification to the sufferer—sufficient in some to lead to suicide. The odor of the sweat is not always repulsive, however, resembling in some instances that of flowers, violets especially. In others, again, it resembles that emitted by goats and even skunks.

The cause of bromidrosis, where it occurs in cleanly subjects, is unknown. As usually met, however, it is due to the too rapid decomposition of sweat in the clothing and particularly shoes and stockings, frequent changing of the latter and

of the underwear and daily bathing preventing all odor. In some subjects, however, even such precautions prove unavailing, especially in respect to the feet. This form has been attributed to a micro-organism, *Bacterium fatidum*, which develops in an acid medium such as decomposed sweat affords. In some patients, the skin of the feet is macerated and appears sodden, grayish, or reddish, especially between the toes and at the soles. Many patients are flat-footed.

Treatment.—**Scrupulous cleanliness** is, of course, of primary importance. The feet should be bathed, using **tar soap**, at least twice daily, and the stockings changed each time. If the odor persists, various powders are useful, dusted in the stocking and between the toes, to prevent it. Weber recommends the following:—

℞ *Pulverized talc*,
Bismuth subnitrate āā ʒiiss (45 Gm.).
Potassium permanganate gr. ʒ¼ (0.016 Gm.).
Sodium salicylate. ʒss (2 Gm.).

Fluids are sometimes more efficient. The following mixture may be used to bathe the parts morning and evening:—

℞ *Zinci sulph.*,
Ferri sulph. .āā ʒiiss (45 Gm.).
Naphtholi,
Olei thymi,
Acidi hypophosph. āā gr. viij (0.5 Gm.).
Aqua ʒviij (250 Gm.).

In some instances **potassium permanganate** or **boric acid** in the water used to bathe the feet suffices. Thin recommends that **cork soles** (or if unavailable, several sheets of blotting-paper), **soaked** in a saturated **solution of boric acid** and dried, be worn inside the shoe. Several pairs of these soles kept washed and saturated may be used, thus protecting the feet and shoes efficiently. Even where blisters and abrasions were present, Benians obtained excellent results from applications of **glycerin** well spread over the soles and toes after bathing, before the socks were put on. The glycerin acts by preventing the formation of noxious products of decomposition. Sabouraud recommends the

use of a 4 per cent. solution of chromic acid in distilled water. The lotion is applied briskly by means of a plug of cotton-wool, care being taken that the liquid thoroughly penetrate between and under the toes. The treatment should be repeated daily for a few days, then every second day, then every third day, till finally an application once a week is sufficient. **Formaldehyde** is another excellent remedy.

The feet should first be thoroughly washed with warm water and soap, rinsed, and dried. Then the soles and the skin between the toes are painted with equal parts of 35 per cent. formaldehyde and distilled water. The solution should dry before the foot is covered. This treatment should be repeated three days in succession. The effect is prompt and lasts for four to six weeks, when the application should be repeated. The sweating, and the fetor to which it gives rise, are often permanently cured. Althoff (*Deut. med. Woch.*, Dec., 1914).

In stubborn cases, which, according to Hale, are probably of neurotic origin, and are not infrequently met in armies, this surgeon sends the patient with all his foot-gear to the hospital. Every pair of his socks is soaked for an hour in **bichloride solution**, 1:2000, thoroughly rinsed in hot water, and carefully washed. His shoes are painted, on the inside, with a solution of 1 ounce of **salicylic acid** in 4 ounces of **alcohol**. The feet themselves are washed, dried and painted with this solution, attention being paid to the interdigital clefts. The entire skin surface becomes white from the decomposition of the salicylic acid, after the alcohol's evaporation. Clean socks are then put on and next day the painting is repeated. Permanent cure, Hale says, follows 2 treatments, cleanliness of feet and foot-gear alone being necessary to maintain it.

Another efficient remedy, according to Legoux, is the following: The feet are first bathed twice daily for several days in a weak infusion of **walnut-leaves** and then anointed twice daily with the following solution:—

<i>B Glycerin</i>	3iiss (10 Gm.).
<i>Perchloride of</i> .	
<i>iron</i>	3j (31 Gm.).
<i>Essence of berga-</i>	
<i>mot</i>	℥xx (1.3 Gm.).

CHROMIDROSIS, OR COLORED SWEAT.—The cutaneous product in this rather rare condition is, as a rule, either blue, red, yellow, black, brown, pink, or any intermediate shade, including either of these colors. It is not, however, as its name suggests, always secreted by the sweat-glands, but may be due to disorders of the sebaceous glands or of pigmentation, or to chromogenic organisms. The **black sweat** (*stearrhœa* or *seborrhœa nigricans*), which may not, however, be pure black but slate-like or, again, resemble black varnish and show a predilection for the eyelids and face, may appear suddenly, as does sweat, and has coincided with hysteria in most subjects. It corresponds chemically with the brown pigment of the retinal epithelium. Millee, however, has observed a form which yields to antiseptics, thus suggesting some bacillus as cause. **Red and pink sweating**, usually of the armpits and external genitalia, has been traced by Stott to a torula, which he obtained in pure cultures, the intensity of the color varying inversely with the temperature. Heidingsfield has attributed red chromidrosis to some form of erythro-micrococcus tetragenus infection, but on weaker grounds. Of another order is the **yellowish-brown** or **brown "sweating."** The oily and resinous character of this excretion, which is readily soluble in chloroform, point to an anomaly of pigmentation, the sweat and sebaceous glands and the hair-follicles being normal. Brown sweating of the armpits has also occurred after the prolonged use of coal-tar remedies. In **blue sweating** (*cutaneous cyanopathy*) two different conditions may probably act as cause, since in one class of cases it is as rapidly formed as sweat while in the other the product accumulates on the skin as a bluish, greasy powder which does not yield readily to water, while at once removed with ether, alcohol, or chloroform, in keeping with the product of the sebaceous glands, or other

fatty materials. Blue sweating generally occurs in neurotic women, and is apt to be most marked before menstruation and during obstinate constipation. The condition must be differentiated from *argyria*, which, as is well known, is due to the prolonged use of silver nitrate and from the blue sweating sometimes caused by potassium iodide. **Green sweating** is sometimes observed in workers in copper.

TREATMENT.—The foregoing data point to the need of studying the cause of the disorder in each case and of removing it. Inability to remove the excretion with water, its prompt removal by alcohol or ether, will point to the nature of the secretion. In the former case local remedies fail; the tone to the sweat-glands should be activated by very small doses of **pilocarpine** or, if the sweating is excessive, of **atropine**. Stimulation of the skin by means of **salt baths** or **static baths** is very helpful. Where the morbid excretion is fatty it is best treated with a saturated solution of **sulphur** in **benzene**. This applies also to the parasitic forms, but here the **yellow iodide of mercury** ointment has given the best results.

TUMORS OF THE SWEAT-GLANDS.

—These organs may be the seat of tumors, but considerable confusion still exists concerning their pathological differentiation. Some seem to spring from the coil-gland and have been termed collectively: **spiradenoma**; others from the duct, **syringadenoma**. Others, again, are cystic owing to the presence in the sweat-coil of a cavity containing a more or less viscid fluid, **cystadenoma**, with local hyperplasia and widening of the canal. The latter forms nodules varying in size from a barley-seed to a pea, the smaller being hard and the larger soft. They may occur in large numbers on various parts of the body. Among other tumors may be mentioned **benign epithelioma**, **carcinoma**, and **adenocarcinoma**, which, when situated on the vulva, syringadenoma closely resembles.

Treatment.—**Surgical removal** or **cauterization** by means of **galvanocautery** are the only effective methods available. S.

SYCOSIS. See **HAIR, DISEASES OF.**

SYMBLEPHARON. See **EYELIDS.**

SYNOVITIS. See **JOINTS.**

SYPHILIS.—ETIOLOGY AND

SYMPTOMS.—Syphilis is due to the inoculation of a healthy individual with the secretion of a syphilitic subject or syphilitic blood containing the specific organism. Though usually transmitted during sexual congress, it is quite often innocently contracted in other ways—syphilis insontium. The conditions for inoculation are such, that the disease may be transmitted extragenitally with great facility. It occurs through contact of the germ with a surface from which the epidermis has been removed. The removal of the epidermis is essential, the syphilitic infection having no corrosive properties *per se*.

Clinical experiences that apparently disprove this assertion are explicable by additional factors; if the infection be associated with another type of infection which possesses specially corrosive properties, the epithelium may be destroyed by the latter, this facilitating the absorption of the former. Uncleanliness favors the maceration and removal of epithelium. When syphilis is associated with chancroid—the most corrosive of the venereal infections—the absorption of the syphilitic virus is greatly facilitated. Traumatic removal of the epithelium facilitates entry of the micro-organism and accounts for a relatively speedy development of the primary syphilitic lesion.

When adventitious local circumstances favor a development of extreme sensitiveness and a tendency to abrasion of the epithelium under slight causes, the predisposition to infection is greatly enhanced. Extreme length of prepuce in the male

and of the labia in the female are important predisposing causes; also alcoholism, for two reasons: first, because it tends to produce irritability of the mucous membranes of the sexual organs; second, because of its tendency to produce moral obliquity and indifference as to the results of sexual excess. Often individuals, while under the influence of alcohol, contract syphilis from sexual exposure which would be abhorrent to the patient when in his normal condition.

The virus, long suspected to be a germ of some kind, now has been positively demonstrated and accepted to be a minute organism of the protozoön type, spirillar in form.

Incubation Period of Syphilis.—

After the micro-organism of syphilis has entered the tissues a certain period elapses before its morbid effects become manifest. This period lasts, upon the average, about twenty-one days, but varies considerably from this in different cases. Fournier relates a case in which the period was seventy-five days; Guérin, one of seventy-five days; and the writer has noted a case of seventy days. The period may be shorter than usual; thus, Hammond relates one of three days, and Nott reported his case as developing within twenty-four hours after wounding his finger in operating upon a syphilitic subject. Taylor reports a case in which the initial lesion appeared upon the second day, induration upon the fourth day, and general symptoms during the sixth week. It may, however, be accepted, as a practical rule, that true chancre does not appear before the tenth day. Any sore appearing prior to that time is probably chancroid, a "mixed"

sore, or some simple affection, while any appearing later is quite likely to prove to be true chancre.

Specific Micro-organism of Syphilis.—Fessenden Otis some years since claimed that the *contagium* consisted of a degraded infectious cell of very minute proportions, acting by incorporating itself with the normal leucocyte and its derivatives. This view is the more striking because in nowise inconsistent with the germ theory. By supposing the incorporation of a specific bacillus with the "syphilitic germinal cell" of Otis, his views were in harmony with the bacillar theory. Personally, as a disciple of Otis, his theory seemed to me to be the most rational and useful of all in teaching syphilology. Even today it is logical in explaining what I will term, for want of a better word, the "mechanics" of syphilis.

The discovery of the *Treponema pallida* by Schaudin and Hoffman was the beginning of the end of all controversy regarding the germ origin of syphilis. This organism has been found by different observers in every lesion of syphilis, including even the gummata of late syphilis, and in brain and cord lesions. One of the most striking facts regarding it is its discovery in the brain in parietic dementia. It occurs in special abundance in the chancre and mucous patch. It has not been found in non-syphilitic lesions. Monkeys have been inoculated with syphilis, chancre induced, and the spirocheta found in the chancre. The crucial test of pure culture and inoculation has finally dispelled all doubt as to its specificity.

The physical characteristics of the spirocheta are distinctive. It is a slender, actively motile, spiral, slightly

refractive organism, varying from 5 to 21 microns in length, and about $\frac{1}{2}$ micron in thickness. It has from 5 to 12 corkscrew-like twists. These twists are regular in the recent specimen—less so as the specimen ages. It is to be differentiated from the *Spirocheta refringens* and *Spirocheta buccalis* (*S. dentium*), which are larger and wavy in outline rather than of corkscrew shape, and are less actively motile than is the *Spirocheta pallida*. The motion of the latter may be described as a "bending" or "twisting."

Primary Local Changes.—Syphilis practically is constitutional from its inception, because we have thus far no generally reliable means of preventing its systemic results. Yet, clinically and pathologically, the disease is exclusively local during the first few weeks. So true is this that the recent revival of what I am free to confess appears to be a "broken reed" in syphilotherapy, excision of the chancre, is not astonishing.

The first effect of the syphilitic infection is a gradually increasing accumulation of leucocytes at the site of inoculation, produced by a modification of the normal leucocytes and connective-tissue elements through the influence of the infection. This probably begins immediately after infection. It is, however, gradual in its progress; hence a certain period elapses before changes are apparent.

The accumulated previously normal cells (the syphilized cells of Besiadecki, Otis, *et al.*), according to their theory, contained the germs of the syphilitic infection. Under the pernicious influence of the syphilitic infection, the cells became larger, more granular, and developed numerous nuclei; were infectious, and

possessed exaggerated powers of proliferation and ameboid movement, together with a marked tendency to retrograde metamorphosis.

Taking as our point of departure the initial lesion of syphilis, we note a localized proliferation of the now infected and perverted cells, and, following the infection in its course, thickening of the lymphatic vessels and enlargement of the lymphatic glands. After a time infection-bearing—*i.e.*, spirocheta-carrying—cells, or, perhaps, independent spirochetæ—or both—enter the *receptaculum chyli*, and finally are emptied into the circulation via the thoracic duct, then to be driven to the superficies of the body, the central nervous system, etc.

Various secondary phenomena now occur: General adenopathy, as a result of (1) the proliferation of the cells carried to them by the blood, (2) the proliferation of their own lymphoid and connective-tissue elements under the stimulus of the spirochetæ and their toxins, (3) an accumulation of infected material collected by the absorbents from the superficies of the body. Engorgement of the fauces and pharynx follows, due to proliferation in their rich network of lymphatics. Mucous patches are likely to occur, and are quasi papules, due to a circumscribed collection of the characteristic cells,—constituting syphilitic granuloma in whatever lesion it may be found. The same description applies to the true papule on the skin. This may have an excessive accumulation of cells and become a tubercle, or, from pressure and interference with nutrition of the normal tissue-elements, plus local syphilotoxemia and their own tendency to retrograde metamor-

phosis,—with or without complicating pus-infection,—there may be formed a pustule that may break and result in ulceration. Nodes or periosteal swellings are collections of proliferating syphilitic cells—granulomata. Secondarily, bone atrophy, hyperplasia, necrosis or caries may result. Bone dystrophy from trophoneurosis may occur (*vide* author's paper in *N. Y. Med. Record*, Jan. 9, 1913: "Unique Case of Syphilis of the Cranium, Remarks on Syphilitic Bone Dystrophy," etc.).

The foregoing are the essential points in the pathology of active syphilis, as expounded by Otis, and, with certain modifications taught by the author, modernized by the addition of our microbial knowledge of the disease. There are, however, many phenomena in the course of syphilis to which the syphilized cell bears no particular relation. Those inexplicable on the ground of localized cell-accumulation and tissue-obstruction are at once rationally explained by the action of syphilitic toxins. The syphilized cell may reasonably be regarded as a carrier of, or as a collaborator with, the spirocheta of syphilis in toxin production.

The danger of permanent injury to the tissues is proportionate to the amount of accumulated cells, the duration of their contact, and the quantity and perniciousness of the syphilotoxins. In explanation of the foregoing Otis says, "The natural course of the syphilitic cell is to accumulate in and obstruct various tissues, thereby forming neoplastic masses similar in structure to inflammatory neoplasia, and finally to undergo retrograde metamorphosis and elimination, resulting eventually in

spontaneous cure of the disease." This view is logical enough, and is not likely to be quarreled with, save perhaps as to the "spontaneous cure."

As to the tissue-changes at the site of inoculation, the first manifestation of the disease is a peculiar lesion characterized by induration, due to accumulation of cells in the meshes of the connective tissue and tunica adventitia of the vessels. The cells in the vascular walls are either round, spindle-shaped, or branched; but the bulk of the mass consists of the characteristic round, multinuclear, granular cell, derived by transformation of leucocytes or their derivatives. The changes are similar to those of simple dermatitis, save in the absence of exudate, the absence of fluid probably depending on thickening and contraction of the blood-vessels, rendering it difficult for serum to exude from them. This would also explain the relative local anemia and diminished nutrition. The syphilitic infection *per se* has very feebly irritating properties. Such as it has are chiefly due to mechanical effects and to a very moderate action of the syphilotoxins. Yet, the latter, extending over many months or years, often produces very disastrous results in various organs.

The peculiar affinity of the syphilitic process for the lymphatic tissues is evidenced throughout. The small blood-vessels are surrounded by perivascular lymph-spaces; it has been claimed that the tunica adventitia of the smaller vessels is really a part of the lymphatic system. This arrangement is related to well-known facility with which infections are taken up from the lymphatics and conveyed to the general circulation.

It also explains general lymphatic involvement in infections that primarily enter the general circulation.

The evolution of the other elements of the local manifestations of syphilis—*i.e.*, primary lymphoplasia and adenopathy—practically is a duplication of the changes occurring in the initial lesion. Within a few days after the latter appears, the lymphatic vessels enlarge and harden, often resembling pieces of pencil or wire beneath the skin or mucous membrane. The degree of inflammation depends upon the amount of secondary irritation of the primary lesion and the presence or absence of mixed infection. Typically, the lymphatic lesion is a hyperplasia rather than a true lymphitis.

The local infection travels with slowness and deliberation. After a time a primary adenopathy occurs. No general involvement of the lymphatic glands occurs for some weeks, apparently not until the infection has had time to reach the general lymphatic system via the tissue-lymphatics, the central lymphatic circulation, and the general blood-circulation.

Each involved gland would appear to be a *dépot* for the storing up, production, and finally for the distribution of the infection. Each gland undergoes a tissue-hyperplasia similar to that of the initial lesion, and becomes hard and woody to the touch.

The changes at the site of infection and in the lymphatic glands and vessels first involved have been termed the *initiatary period* of syphilis.

The Initial Lesion, or Chancre.—

The typical initial lesion is an induration, pure and simple. But the facilities for mixed infection and irri-

tation are so many that a simple induration, with absolutely no solution of continuity of skin or mucous membrane, is exceptional. The chancre may present itself in the following forms: (1) Simple erosion—a superficial loss of epithelium forming a non-suppurating open lesion. (2) A greater or less area of ulceration, saucer-shaped, due to irritation and simple pus-infection. (3) A deep ulcerative excavation with sloping edges. (4) Herpetiform and crustaceous chancre. (5) Diphtheroid or so-called “diphtheritic” chancre. (6) An indurated, non-secreting *plaque*, papule, or tubercle. The open varieties, of course, present in typical instances an underlying more or less characteristic induration. (*See colored plate.*)

Erosion may be said to include about two-thirds of chancres, and usually is situated upon the mucous membrane, very often inside the prepuce in the male. In shape it is oval, or perhaps a trifle irregular, with a raw, polished surface of a wine-red color and sometimes a pultaceous thin, sanious fluid, entirely or almost devoid of pus. These erosions are flat, and may surmount a thin parchment induration, or may cap a hard tubercle as large as a marble. Superficial saucer-shaped ulceration may be found with the parchment variety, but most often with the split-pea induration. When it caps a large mass of induration, it is apt to be quite deep and funnel-shaped,—the “Hunterian chancre.” This variety sometimes is so large that it surrounds the entire glans, filling the fossa glandis and appearing like a semicartilaginous collar shining white beneath the quasi mucosa.

The secretion from the ulceration is



Syphilitic Sore of Vulva. (*Mrazek.*)

apt to be seropurulent. Herpetiform and crustaceous chancres may occur in any situation. The simple indurated papule or tubercle is usually found upon the skin, the integument of the penis, or even upon the prepuce itself when it is short and dry. Ulceration of this form of induration might occur if it were kept moist. The parts upon which it develops are perhaps not so rich in lymphatic spaces as those in which a chancre is more likely to ulcerate, the collection of cells being consequently smaller and necrobiosis less marked.

Several unusual types of chancre have been described. French authors describe a variety called the "herpetiform." This seems to be simply a lesion of herpes that becomes infected with syphilis and eventually indurates. In some cases the *rationale* of its formation is exceedingly simple. At the time of exposure the surface comes in contact with some local irritant. The patient being predisposed to herpes, one or more vesicles soon form. The chancrous induration develops in the herpetic lesion later on, at the end of the period of incubation. Fournier describes a form of chancre that he terms "crustaceous." This, he claims, may be confounded with scabies. The condition yields to sulphur, which chancre does not. Fournier claims, however, that expectancy is the only recourse in the differential diagnosis.

The symptoms of urethral chancre, when too deep to be seen without the urethroscope, consists in a discharge coming on after the usual incubation, thin, perhaps sanious, but sometimes creamy and thick. There is a painful spot in the urethra in micturition and erection, possibly with a lump in

the course of the canal, at times distinctly perceptible on palpation. The type of the discharge depends on the complicating urethritis. Symptoms of stricture may occur, due to pressure of the chancre upon the urethral lumen. By means of the urethroscope an ulcer often may be detected, and in a short time the primary and later the general enlargement of the glands and other symptoms appear. Great caution is necessary in making a positive diagnosis until these confirmatory symptoms appear, unless the spirocheta can be demonstrated. There is a peculiar form of chancre that may lead to grave errors in diagnosis. This appears as a slight erosion of a milky color, just within the meatus. Induration is not perceptible and the lesion looks not unlike an intraurethral herpetic lesion. The spirocheta may, or may not, be demonstrable.

Varieties of Induration.—(1) The simplest form, the parchment induration, usually underlies ulceration, and is sought by pinching up the lesion with the thumb and finger so as to press lightly upon its edges without bending it. This is the commonest form, according to some authorities, and certainly is so in hospital practice. In private practice, however, the Hunterian chancre, or other marked forms, are more frequent in the writer's experience.

(2) A variety of the parchment induration likely to escape attention consists of a very superficial cell-infiltration, presenting a very slight induration when lightly pressed upon. In appearance it is a slightly brownish patch covered by very fine scales, not unlike a minute patch of psoriasis—the "dry, scaling patch" (Otis).

The author would suggest as a better term, "squamous superficial induration."

(3) The induration may be somewhat like a split pea beneath the skin, its convex surface being capped by ulceration. This induration is freely movable, with a feeling like wood, bone, or cartilage.

(4) The induration may be large and extend beyond the ulceration (where such exists), often attaining the dimensions of a chestnut or almond. When such an induration is ulcerated, it is sometimes capped with a funnel-shaped ulcer,—the Hunterian chancre. Often there is a hard, purplish mass of induration, with no ulceration, or, at most, a very superficial erosion. In many cases induration is irregular, at times presenting several distinct tumors, or united by areas of less marked induration, giving, in the penis, a "choked" appearance to the organ.

(5) A very superficial infiltration may underlie a pseudomembrane of greater or less dimensions: the "diphtheritic chancre" already mentioned.

Diagnosis of Chancre.—(1) Known exposure to contact with a person with active syphilis, whether the contact be sexual or otherwise. The surgeon or obstetrician should be on guard, especially where attendance on a syphilitic is known to have preceded a suspicious lesion on the hand.

(2) The period of incubation. This often is worthless—usually so when there have been numerous exposures. A single exposure, preceding the appearance of a sore ten days or more warrants the suspicion of syphilis.

(3) Induration. A large, hard, movable, insensitive, semicartilaginous, anemic-looking induration is con-

clusive to the expert, but there are so many degrees of induration of genital sores that it alone is not diagnostic.

(4) Discovery of spirochetæ in the chancre secretion. This is conclusive.

(5) A positive Wassermann test. This, if of high degree, and in cases in which previous syphilis can be excluded, is conclusive. When the reaction is not marked, or when it shows soon after the sore appears, the syphilis probably antedates the suspected lesion. The Wassermann test shows nothing until after general infection has occurred, *i.e.*, on the average in about six to eight weeks.

(6) Secondary symptoms.

Loss of Tissue in Chancre.—The ulceration in a chancre is important, and, aside from irritation, it is explicable by the histological characters of the lesion. The localized cell-accumulation not only presses upon the capillaries, but actually invades their walls. The resulting malnutrition leads to breaking down of the superficial layers of the lesion, which, becoming infected, form an ulcer.

The induration of chancre is variable in its extent, according to the tissues in which it is situated. When an extensive cut or abrasion is inoculated, the resulting chancre is likely to assume the size and conformation of the traumatic lesion.

In quite rare cases of chancre, or apparently simple lesions followed by constitutional syphilis, induration appears to be entirely absent. It may be overlooked through carelessness or its coexistence with chancroid, or may be so slight as to escape attention. After a chancre becomes phagedenic, induration shortly disappears.

It is a peculiar fact that typically

indurated chancre is rare in women. Contagion is oftentimes spread about while the patient is entirely unconscious of her trouble. This is true, not only of the chancre, but of the mucous and quasi-mucous lesions.

In simple chancre the induration most generally precedes the ulceration, but often follows it, coming on during the first week. Primary ulceration is probably due to some irritant or to simultaneous chancroidal or purulent infection. This is the invariable course of mixed sores, and probably most lesions in which induration follows ulceration, instead of preceding it, are primarily either chancroid, herpes, or simple ulceration from pus-microbes.

The induration of chancre may be slight and may disappear so rapidly as to be overlooked. Cases have been observed in which it lasted only ten or twelve days, but the ordinary duration is one to three months, in improperly treated cases; in rare cases lasting for some years. In cases of syphilis in which there is no history of antecedent chancre, the author believes that an initial lesion has appeared and disappeared without having been observed.

Secretion of Chancre.—This is scanty and seropurulent, and remains so throughout unless the sore becomes inflamed, then being profuse, purulent, and perhaps bloody. Some chancres exhibit a marked and persistent tendency to bleed: the so-called "hemorrhagic chancre." The author recalls one case of this sort in which later "transformation" into epithelioma occurred.

Many attempts at autoinoculation have been made with syphilitic secretions, thus far in vain, as a rule.

When a chancre is inflamed and secreting profusely, its secretion—containing toxins and pyogenic microbes—will produce a pustule if autoinoculated. This may be followed by ulceration, but never by hard chancre. When the sore is mixed, autoinoculation is, of course, feasible.

The secretion of a chancre, and blood or serum drawn from it, contain the *Spirocheta pallida* and are virulently infectious.

Comparative Frequency of Chancre and Chancroid.—Fournier finds in private practice that the frequency of chancre as compared with chancroid is about three to one. Yet the statistics of ten years at one of the large Paris hospitals show that chancroid comprised about 80 per cent. of sores. From clinical experience the writer is inclined to believe that these estimates are fair criteria in private and hospital practice. In hospital practice, however, patients with atypical and possibly mixed sores often are lost sight of after they leave the hospital. Doubtless many of these afterward develop syphilis, thus cutting down the percentage of simple chancroids.

Complications of Chancre.—(1) First and simplest we have vegetations or papillomatous growths: the so-called "venereal warts." These result from local irritation combined with heat and moisture, and are identical with vegetations occurring under other circumstances. The writer believes that, while in no sense syphilitic, they, like herpes progenitalis, thrive best on syphilitic soil. Proper cleanliness usually will prevent them. (2) Inflammation of chancre, giving rise to considerable pain and profuse

purulent secretion. (3) Chancre may be complicated by chancroid, constituting "mixed sore,"—unless the two forms of disease appear in different locations. (4) Chancre may be attacked by phagedena or gangrene.

Mixed Chancre.—When a chancre becomes inoculated with chancroid, its ulceration deepens and it gradually assumes the general characters of chancroid; but, unless phagedena occurs, induration usually still persists. Oftener than usually is supposed, however, the chancroid inhibits the chancrous induration, thus, syphilis oftentimes follows an apparently typical soft sore. Slight sclerosis is apt to be melted away by the chancroid and thus escape attention. When chancroid develops primarily—from typical mixed infection—it generally runs its usual course until the incubation period of syphilis has elapsed, when induration occurs. The secretion of the mixed sore contains the spirocheta, is autoinoculable, and transmits either or both diseases to a healthy person. In some cases chancroid rapidly heals, or the incubation period of syphilis is long, and induration develops in the cicatrix of the chancroid after it has soundly healed.

The test for mixed chancre is: (a) search for the spirocheta, (b) auto-inoculation. By the term autoinoculable is meant a sore the secretion of which, inoculated in a new situation in the diseased individual, will produce typical chancroid.

Both poisons may be contracted at once or either variety of genital lesion may develop primarily and later be inoculated with the other disease.

The chancre may undergo trans-
formation when situated in a

moist locality, such as a mucous or quasi-mucous surface, it may lose its hardness and at the same time become transformed into a quasi-mucous patch by becoming covered with a characteristic whitish pellicle. At times the sore acquires the form of the mucous patch, yet retains its induration. The "diphtheritic" variety, first described by Morrow, possibly may sometimes be the mucous transformation just described, but the author has met with a number of cases exactly corresponding with Morrow's description.

Phagedenic Chancre.—Phagedena attacking chancre is likely to be of the gangrenous form. The pultaceous and serpiginous varieties are rare. After phagedena once has invaded a chancre, induration no longer is perceptible. If the sore be of the mixed variety, the pultaceous or serpiginous form of phagedena is then likely. Bassereau and Diday believe that the type of syphilis following phagedenic chancre was exceptionally severe. This is true in my experience, but is explicable by the fact that phagedena, *per se*, probably is due either to general debility or to a peculiar diathesis that lessens the resistance to disease. Phagedena probably is due to mixed infection in which streptococci play a leading rôle, associated with a lack of tissue resistance.

Infectious Secretions in Syphilis and Infection.—Inoculations with the secretions of chancre and of mucous patches, and also with syphilitic blood have been made with entire success. Whether the blood is infectious between the periods of active manifestation of the disease has not been determined by experiment, but from accidental observations made upon

vaccinal syphilis it probably is. The discovery of the specific spirocheta in the blood, and the results of the Wassermann test in "intervals of quiet" in syphilis, substantiate the foregoing opinion, originally expressed by the author in 1885. The secretions of non-syphilitic lesions occurring upon a syphilitic are not inoculable unless mixed with his blood, *e.g.*, the secretions of gonorrhea and chancroid in a syphilitic transmit only gonorrhea and chancroid unless they contain syphilitic blood. Diday inoculated pus from acne pustules produced by potassium iodide on a syphilitic subject, but with negative results. It probably also is true that a vaccine-lymph derived from a syphilitic is not capable of producing syphilis unless it contains some of his blood. This, however, should make the physician no less cautious, for it is easy for blood to mix with the lymph and remain undetected. The vaccine-scab from a syphilitic patient always is dangerous.

Inoculations with the secretions of tertiary lesions and with blood during the tertiary stages are negative, with some apparent exceptions. Presence of the spirocheta seemingly should throw any case out of the category of tertiary phenomena. As to whether the same can be said of the Wassermann test appears an open question.

The relative non-transmissibility of tertiary syphilis has been claimed as evidence that the lesions of this stage are not syphilitic at all, but simply sequelæ. Neither the mucus, sweat, urine, milk, nor semen, are inoculable, unless mixed with blood or secretions of a lesion containing the spirocheta. Even the saliva is innocuous unless mucous patches or

other lesions exist in the mouth, in which case it is contagious in the highest degree. The spirocheta must be present, else no secretion can transmit syphilis. Furthermore, the spirocheta is not always readily demonstrable.

In every method of transmission of syphilis, save two, the general disease always is preceded by chancre, and the existence of the latter may be inferred. Chancre is never present in the case of (1) infection of the child *in utero*, and (2) infection of the mother through the child—the latter method still a subject of controversy.

Modes of Contagion.—Contagion may be mediate or immediate. The former means transmission of syphilis through the medium of infected drinking-utensils, tobacco-pipes, towels, etc. Chancroid is rarely thus transmitted, but syphilis often, because of the multiplicity of its lesions, some apparently insignificant, yet infectious. By immediate contagion is implied direct contact of an abraded surface with a secreting lesion or infected surface or with syphilitic blood from a non-syphilitic lesion in a syphilitic subject. The type of this mode of contagion is, of course, infection during sexual intercourse, but it may occur in many other ways; often it is contracted in operating or examining syphilitic subjects, or in delivering syphilitic women. The use of rubber gloves eliminates this danger.

Chancre often is contracted in kissing, a small, perhaps unrecognized mucous patch on the cheek, lips, or tongue of the diseased person inoculating any slight fissure or abrasion present about the mouth of the healthy subject. Sources of especial danger are unnoticed oral lesions.

Duration of Chancre.—The chancre may last for only two or three weeks, but in the majority of cases an eruption appears prior to its disappearance. It may last for months, especially if complicated. The induration may last for years. Under proper treatment it usually disappears promptly, unless very extensive, when it may be very slow in resolving.

Number of Chancres.—Chancre generally is single, but may be multiple, according to the number of points primarily inoculated. It usually is situated upon the genitals, behind the corona glandis in the male especially; but its situation varies very greatly. Initial lesions of the face, tongue, nipple, and fingers are not so very rare, and many chancres of the tonsil have been reported. The author has met with two cases of chancre of the eyelid. Urethral chancre is not uncommon.

GENERAL INFECTION, CONSTITUTIONAL, OR SECONDARY SYPHILIS.

The initiatory period ends when the infection has traversed the lymphatics, entered the receptaculum chyli, and thence passed into the blood. No tissue enjoys complete immunity from the ravages of the disease. We will consider the various phenomena as they appear in a typical case.

Following the initiatory period, with its initial sclerosis and primary adenopathy, there is an apparent period of incubation lasting, on an average, forty to forty-five days, and followed by general symptoms. During this so-called second stage of incubation the syphilitic infection is

slowly traversing the lymphatics and making its way into the blood.

DIAGNOSIS.—**Constitutional Syphilis.**—The diagnosis of constitutional syphilis is established from the lesions shortly to be described, and by the blood test:—

Wassermann Test.—This depends on the principle of complement fixation by union of a particular bacterial substance with the antibodies of infected blood. In the standard test, the suspected serum is mixed with extract from the liver of a syphilitic fetus. If syphilis be absent, complete hemolysis occurs. If it be present, hemolysis results of a degree inverse to the intensity (activity) of the infection. For the technique of the Wassermann test, the reader is referred to the fifth volume, page 385.

Sources of Fallacy.—(1) The test fails in a certain proportion of syphilitics; (2) a positive reaction not infrequently is obtained in other diseases, and in presumptively healthy persons; (3) a mildly positive reaction, when taken alone, is not conclusive; (4) a negative reaction means nothing definite.

It must be admitted, despite the foregoing sources of fallacy: (1) that varying degrees of competency of laboratory workers exist; (2) that a strongly marked positive reaction may be taken to mean syphilis.

The known fallibility of the Wassermann test and the inequalities of expertness of laboratory workers limit the usefulness of the test, greatly to the detriment of a large proportion of syphilitics. Thus, in one case of a physician suffering from a suspicious lesion of the palate, three or four Wassermans and several examinations for the spiro-

cheta had been made, with negative results. The lesion was typically syphilitic, and I so stated. Dr. Joseph Zeisler confirmed the diagnosis. Later, the lesion was pronounced by an eminent authority *I'ncenti angina*. Several positive Wassermanns subsequently were obtained. The patient was treated for a few months, and for two years thereafter frequent Wassermanns were negative. Later they were again positive.

Noguchi's luetin test is not constant in lues. It is more frequent in late than recent cases. While the Wassermann tends to become negative under mercury, the luetin remains unchanged. A. Chieffi (*Giorn. ital. d. mal. ven. e d. pelle*, May 26, 1918).

Lange's colloidal gold test confirms other tests. It is valueless unless a satisfactory indicator is prepared. In tabes it may predict paresis. In tabes and cerebrospinal lues it may be positive where the Wassermann, cell count and globulin are negative. In general paresis it is invariably positive. In normal fluids it is invariably negative. Harvey (*Calif. St. Jour. of Med.*, 16, 170, 1918).

General Adenopathy.—The infection, after entering the right heart, is finally disseminated throughout the tissues, producing (a) toxemia and (b) cell-proliferation, the first evidence of which usually consists in a general glandular enlargement. This, however, may coexist with or follow the roseola. The enlarged glands now encountered are reproductions of the initiatory adenopathies.

The Roseola.—At the end of about forty to forty-five days, on the average, after the chancre, a period of "general, systemic infection and localized cell-accumulation" begins. The first evidence of general infection is usually a peculiar eruption of rose spots: the roseola. Although this

eruption may escape observation, it probably is constant, in some cases lasting for some weeks, probably from two to eight, in others only a few hours. In its general appearance the eruption is not very unlike measles. The spots are of a dull, rose-red hue, and disappear on pressure when recent, though later on leaving a coppery stain.

The syphilitic roseola is due to dilation of the cutaneous capillaries, with subsequent stasis, and the exudation of leucocytes and red blood-corpuscles. Possibly the dilation and stasis are reflex phenomena due to local irritation by the syphilitic infection, or to the direct influence of the infection upon the vascular walls; but a more rational explanation is that of a direct influence upon the sympathetic centers analogous to that produced by quinine, belladonna, etc., and by emotions. In the previous editions of this work, and in his "Lectures on Syphilis," 1885, the author said: "The disturbing element in the action of syphilis on the sympathetic is probably a toxin or toxins elaborated by the syphilitic micro-organism." The discovery of the spirocheta justified our early conclusions.

Syphilitic Prodromes.—The roseola may be preceded or accompanied by malaise, headache, backache, rheumatoid pains, anorexia, nausea, prostration, sleeplessness, and nervous irritability, and in some cases quite sharp febrile movement, perhaps followed by perspiration. These are the symptoms of "syphilitic fever," or, as Diday more correctly terms them, "syphilitic prodromes." It has been claimed that these symptoms may depend upon so many coincident

disturbances that the term syphilitic fever is obviously inaccurate. This observation, however, may be fallacious because of faulty methods of study. The various symptoms are toxemic, and, although they vary in severity, probably might be demonstrated in all cases by careful investigation. The temperature, be it remarked, rarely is studied.

Pharyngofaucial Infiltration.—About the time the roseola appears, there is a development of inflammatory engorgement of the tonsils, pharynx, and soft palate, usually involving the whole faucial surface. The explanation of this involvement on the basis of lymphatic engorgement, due to the abundance and superficiality of the lymphatic capillaries of the affected parts, is quite plausible. That vasodilation due to the action of syphilotoxins upon the sympathetic is an associated factor, seems probable.

The Papular Syphilide.—After the roseola in typical syphilis appears an eruption of true papules. This may occur when a roseola has not been noticed, or coincide with it, but generally follows it after a variable interval: often some weeks or months. The papules usually are most prominent about the borders of the hair upon the forehead, forming the *corona veneris*, or "venereal crown," but may be scantily scattered over the breast, back, and limbs, or thickly studded all over the body. This eruption lasts longer than the roseola, occasionally remaining prominent for a number of months. At first it is of a rather bright-reddish hue, but this gradually fades, leaving the characteristic coppery red color, due to deposition of blood-pigment in the

congested area sublying and superimposed upon the lesion.

Syphilitic Alopecia.—As a rule during the early months of the secondary period, often coexistent with the papular eruption—falling of the hair, or alopecia, occurs, due to disturbed nutrition in the hair-follicles. The loss of hair may be general, but it usually occurs in quite characteristic patches.

This lesion of early syphilis especially appeals to the writer as a trophoneurosis. This may be dangerous ground, for the close association of alopecia with tangible cell-deposit in other situations has led to its tacit acceptance as an evidence of the action of syphilis *in loco*. But it is not unusual to find papules from which the hair has not fallen interspersed with non-infiltrated alopecia. In most cases the alopecia seems to bear no effect relation to cell infiltration. Some authors ascribe it to local "poisoning" of the hair-follicles.

Syphilis of the Nails.—The nails of the fingers and toes may become brittle and lusterless, or from very great infiltration and nutritive disturbance—and perhaps secondary pus-infection—syphilitic onychia may occur, presenting obstinate ulceration around and beneath the nail.

Pustules, Vesicles, and Precocious Skin-lesions.—Pustules or vesicles may form during the papular stage, as may also ulcerations resembling tertiary or late secondary lesions. The latter constitute precocious syphilides. These lesions are due to (a) pressure on nutrition, (b) local tissue intoxication, (c) special coincidental irritation, and (d) pus-infection.

Special Mucous Lesions.—These are modifications of the syphilitic

papule resulting from a different situation and surroundings. Mucous patches, constantly subjected to irritation from friction, heat, and moisture, are examples. These lesions are elevated *plaques* of a milky or grayish color, covered with a grayish exudate, and are not greatly unlike the primary superficial erosion sometimes seen upon the genitals. When situated in relatively moist and uncleanly regions—*e.g.*, about the anus, upon the scrotum, vulva, or between the digits—they hypertrophy, forming broad papules or excrescences more or less elevated, sometimes covered with a quasi-diphtheritic deposit, and usually discharging a foul-smelling, serous secretion. These are mucous tubercles, or condylomata. Almost typical papillomata may complicate them.

Visceral Involvement.—Visceral involvements are common in syphilis, congestion characterizing the early secondary, diffuse infiltration the late secondary, and distinct gummy deposit the sequelar period. Tenderness over the liver, spleen, and kidneys is occasionally observed in early syphilis. Transient albuminuria is not uncommon. The author repeatedly has called attention to the danger of late complications developing in viscera affected in the early stages.

Early Ocular Syphilis.—During the active period an infiltration of cells into the iris and ciliary body often sets up an iritis in no way distinguishable from the iritis of rheumatism, trauma, etc. Later the cell accumulation sometimes forms a distinct nodule, or tumor, often erroneously termed "gummy tumor of the iris." This is especially likely to occur in late syphilis, in which event

it may, perhaps, be justly styled "gummosus." Similar plastic nodules may form in the choroid at this period. In late syphilis the eye may be involved secondarily to brain lesions, by necrosis or caries of the orbit, or by retinal involvement, resulting in optic atrophy.

Early Osseous Symptoms.—Bone pains, usually localized, and localized subperiosteal accumulations of cells termed nodes frequently occur during early syphilis, although more characteristic later. Pain is due to intraosseous or subperiosteal pressure by the dense accumulation of cells.

Early Nerve Involvement in Syphilis.—Syphilitic toxins are prominent in early syphilitic nerve disease. They apparently act (a) by direct intoxication of nerve-tissue; (b) by induction of vasomotor changes via the sympathetic ganglia or the so-called monarchic vasomotor center; (c) direct intoxication and irritation of blood-vessels in the nervous system.

Organic or functional nervous disturbance is caused in many ways, viz.: (1) by invading the lymphatics surrounding nervous structures; (2) by involving the tissues round the blood-vessels supplying or draining the part; (3) by invading the arterial walls; (4) by infiltration of tissues contiguous to nervous structures; (5) by involvement of the nerve or brain parenchyma proper; (6) by involving nerve-sheaths or the meninges. These conditions act by: (1) irritation; (2) pressure-innutrition and occasionally degenerations; (3) passive hyperemia and edema from venous obstruction; (4) localized anemia (ischemia) from arterial obstruction; (5) lymphatic obstruction.

Any of these conditions may occur in both the early and the late periods. Extensive destruction from breaking down of the neoplasm is rare in the earlier lesions. Gumma may develop early, however, from the intrinsic malignancy of the disease.

The terms "early" and "late" applied to syphilis are rather indefinite, it is true, but perhaps are the best that can be offered. Gummy lesions occur much earlier in some cases than in others.

LATE SYPHILIS, SEQUELAR OR SO-CALLED TERTIARY SYPHILIS.—The Tubercular Syphilide (Gummy Infiltration).—For over thirty years the author taught that the so-called tertiary lesions of syphilis were "sequelar." With the advent of the *Spirocheta pallida* and its demonstration in many of the late cases, and the frequency with which a positive Wassermann is found in such cases, one would be expected to abandon this sequelar view. The author not only has not abandoned it, but until it has been shown that the spirocheta of late syphilis has lost none of its pathogenic properties, he will feel more firmly than ever convinced that the typical tertiary lesions, and especially the nerve and brain lesions of late syphilis, are sequelar. Supporting this are the following, viz.: (1) The spirocheta and its host are subject to the same biological laws as are other organisms. (2) The primordial controlling law is mutual adaptation of tissue-cell to germ. (3) This adaptation results in an increased tolerance of the host and a lessened virulency of the parasite. (4) Just as the gonococcus may lose its virulency, yet remain indefinitely in the tissues, so may the

spirocheta. (5) Similarly the gonococcus may produce lesions which persist and become permanent, in spite of having become non-virulent. Notable examples are chronic prostatitis and seminal vesiculitis. (6) The complement-fixation test and Wassermann test are analogous in this: viz.: they show that toxemia may be produced long after the germ has lost its primary virulency. They are alike, too, in that this toxemia is absent in many cases in which antecedent syphilis or gonorrhea is undeniable. How else can we explain some of the vagaries of both tests? (7) A recrudescence of activity of both gonococcus and spirocheta may occur, but the lesions long present still may be the results of their pernicious activity long since past. (8) If the so-called tertiary lesions are due alone to the spirocheta, why do not locomotor ataxia, visceral gumma, and paresis occur in early syphilis? Hemiplegia occurs, it is true, but rarely, and usually is followed by complete recovery. That the extent and danger of syphilitic phenomena are in direct ratio to their remoteness from the active period is very suggestive. (9) The long periods of quiescence preceding the tertiary phenomena. (10) The occurrence of slow vascular changes, never manifest until long after the secondary manifestations of the disease. Vessel changes leading to the cerebral hemorrhages of late syphilis are plainly from perverted nutrition and of very slow development. (11) The iodides resolve gummous lesions, but are of little or no specific value in early syphilis.

As to the question of treatment, it is of no importance whether or not

late syphilis be regarded as a period of sequelæ. Possibly, however, regarding it as such may lead to more thorough and prolonged treatment and offset pernicious confidence in salvarsan and the Wassermann test.

The Gumma.—One of the most frequent of the tertiary lesions, or sequelæ, is the tubercular eruption. This has been said to be due to a localized accumulation of morbid cell-material or "gummy infiltration." This gummy material is termed by Wagner "syphiloma," and is described by him as an infiltration of cells indistinguishable from the normal white blood-cells or leucocytes. He states that their morbid effects are due to mere interference with function and nutrition by pressure. Bäumler also claims that the cells of syphilomata lack specific microscopic characters, but are identical with those of granuloma in general.

The tubercular, or gummy, lesion may develop in any situation, its favorite locations being the cellular tissue, skin, bones, liver, testes, brain, and kidneys, and, in children especially, the lungs.

This gummy material is a grayish-red, homogeneous mass of greater or less consistency, found either as a diffused or circumscribed infiltration, but never capsulated. When it is superficial or when it is excessive or involves vessels, causing localized in-nutrition from pressure or vascular obstruction, the whole mass is liable to disintegrate and form an open lesion, or break down into pus or puruloid material that may absorb through fatty or granular degeneration without ulceration. The longer the active period, and consequently the more pronounced the lymphatic

changes, the greater the liability to severe tertiary lesions.

After removal by fatty degeneration there is a tendency to recurrence. Hence the difficulty of curing the disease at this period. This tendency is due to an increased injury to the lymphatic structures already greatly impaired by lesions of the active period. The impairment consists in fibrosis due to low inflammatory action mechanically set up by the cells. This, of course, interferes with tissue-nutrition.

Thus, the various lesions and their different degrees of severity in the "tertiary stage of syphilis" depend upon (1) the damage produced in the active period and its duration; (2) the constitutional condition of the individual; (3) the relative degree of activity of the spirocheta in late syphilis and the degree of virulency of its toxins, and (4) the extent to which injudicious treatment has injured the patient.

Late, or Sequelar, Nerve and Brain Syphilis.—The nervous lesions of late syphilis are more severe, and the prognosis much graver, than in the case of the early nerve phenomena. The accumulation of neoplastic material in and about the delicate nerve-structures, occurring in late syphilis, is associated with and probably dependent upon: (1) The local damage inflicted in the active stage in the form of a fibrosis with vascular and lymphatic obstruction. (2) Permanent disturbance of nutrition, from the toxemia of early syphilis, the effects of which are slow in developing symptoms. (3) The debilitating effects of prolonged syphilization and the prolonged treatment necessitated by it. (4) Prolonged mental worry,

with or without alcoholic or other excesses. (5) At times, immunity to remedies acquired, (a) by the spirocheta, (b) by the patient.

Probably the nerve and brain lesions of this period act chiefly through mechanical and nutritional disturbance, the virulence of the spirocheta having long since become exhausted.

Paralyses—such as hemiplegia, paraplegia, and monoplegias of different kinds—are apt to occur, and are due either to localized deposit of syphiloma external or internal to the structures involved, or to diffuse interstitial deposits and proliferation of obstructive tissue. Gummy tumors may occur in the brain proper or its membranes, or the latter may undergo a chronic thickening resembling chronic meningitis from other causes. Gummy deposits in and about the cerebral vessels are prolific causes of paralysis. Vascular degeneration often is the cause of those miliary aneurisms often the source of apoplexy and hemiplegia.

The various cranial and spinal nerves are likely to become involved. This involvement may be central, with or without coincident brain-involvement, or peripheral, affecting any part or all of the distribution of the nerve. As with the brain, the nerve-lesion may consist (1) of a circumscribed or diffuse gummy deposit; (2) of sclerotic changes produced (a) by lesions of the active period or (b) by sequela gummy deposit; (3) of destruction of normal tissue-elements.

It is well known that gummy infiltration and localized deposits with consequent paralysis occur in the cord, but the extent of the etiological

relation of syphilis to locomotor ataxia was long in dispute. Erb maintained that 61 per cent. of cases of locomotor ataxia are due to syphilis. Since the discovery of the spirocheta and the advent of the Wassermann test, most authorities believe that locomotor ataxia practically always is due to syphilis—hereditary or acquired. In this view the author concurs.

The prognosis of late nerve and brain syphilis is notoriously bad, but often more hopeful than some believe.

Syphilides.—The syphilitic skin eruptions—"syphilides," or "syphilodermata"—are many and often confusing. Where papules are the essential feature of the eruption it is termed a "papular syphilide." Similarly the eruption may be designated as vesicular, pustular, tubercular, squamous, crustaceous, or ulcerative, or as papulopustular, papulosquamous, etc., the first part of the combined term corresponding to the feature of the mixed eruption that is most prominent. Ulcerative syphilides may be designated as superficial, deep, ser-piginous, or perforative.

The principal distinctive lesions of syphilis that occur at various periods during its course are macules, papules, mucous patches, mucous tubercles, condylomata, vesicles, pustules, bullæ or blebs, rhagades or fissures, gummy tubercles, and diffuse gummy deposits and infiltrations. Dependent upon some of these lesions, different forms of deep and superficial ulceration, attended or followed by peculiarly formed crusts and scars, may occur—syphilitic ecthyma and rupia—ulcero-crustaceous syphilides. Squamæ or scales may also be noted.

The general characteristics of the syphilides are [Keyes]: (1) polymorphism of all lesions, including the chancre; (2) rounded form of the eruptive lesions and ulcers; (3) lividity or "ham-color," becoming coppery, then grayish, and finally white and shining as cicatrization occurs; (4) absence of pruritus and pain excepting in hairy regions, and, with respect to pain, in the bones; (5) symmetry, generalization, and superficial character of the early eruptions, in all save precocious or malignant cases; (6) tendency to grouping of the later eruptions, which involve the true skin and tend to scarring; (7) tendency to circular arrangement; (8) scales comparatively thin, white, generally superficial, and non-adherent; (9) crusts irregular, thick, and adherent, greenish or black from admixture of disorganized blood; (10) abrupt edges of both skin and mucous ulcerations, which are not undermined, are sluggish, and bleed easily; (11) rounded, depressed appearance of cicatrices, which are thin, movable, pigmented at times, but eventually becoming white and shining. These scars often are crescentic or horseshoe-shaped.

The term "polymorphous" is applied to the syphilides because there is no form of skin-lesion that may not occur. Indeed, no single lesion usually is present: a papular syphilide rarely is purely papular, vesicles, pustules, or erythematous patches usually being found at the same time.

In addition to the foregoing lesions, syphilitic fever, alopecia, headache, osteocopic pains worse at night, analgesia, anesthesia, indolent lymphitis, iritis, sore throat, and mucous patches are also typical phenomena.

PROGNOSIS.—Baümle claimed that the infection of syphilis lasted from eighteen months to three years. After this, the blood and secretions of open lesions ceased to be contagious, and many held that, in most cases, especially if properly treated, no further manifestations ever were experienced. The advent of the Wassermann test has rather disturbed the severity with which we had come to regard the prospects of a large proportion of syphilitics. It is positive in quite a porportion of supposedly cured cases. This, however, has not disturbed the author's belief that a large proportion of syphilitics, under proper conditions, are curable. The author believes that it is never safe to rely upon any test, laboratory or clinical, to prove that any given syphilitic has been cured. Eternal vigilance and repeated periods of treatment are the only safeguards.

The prognosis as regards severity of syphilis varies with the habits and resistance of the patient and the assiduity in treatment. There is no disease the duration and course of which are so uncertain. One cannot state arbitrarily in any given case that the disease has or has not terminated. This is especially true when we consider that it may permanently modify the patient's constitution, even though no typical manifestations appear after a certain time. No method of blood-examination thus far suggested has proved absolutely reliable. Even the Wassermann test is very frequently fallible.

The disease may manifest itself as a series of mild secondary eruptions followed by apparent recovery, or it may afford no evidence of its presence after the initial sore throat until

late in life, when suddenly tertiary lesions—*i.e.*, sequelæ—crop out.

Curability of Syphilis.—Proof of its curability lies in the cases of second attacks, cited by reliable authorities, and in the fact that, whatever the possibilities of tertiary lesions, they are not necessary, and probably often are sequelæ. Sequelæ syphilitics may procreate healthy children. The blood and secretions of tertiary lesions often seem no longer inoculable. The germ origin of syphilitic infection being admitted, the spontaneous tendency to cure of syphilis is almost beyond controversy. It is part of the life-history of the micro-organism.

The prognosis of syphilis as regards the life of the patient is a matter difficult to determine. Fatal results from syphilis usually are incidental to sequelæ lesions of the arterial or cerebrospinal systems or of the viscera. They occur, as a rule, at a period so remote from the original infection, and the symptoms are so obscure as regards the specificity of their origin, that it practically is impossible to determine the primary cause in many cases. Even a negative Wassermann does not disprove the existence of syphilitic or of post-syphilitic lesions. This much may be said, however, namely: Active syphilis is a disease that is essentially benign, *per se*, so far as danger to life is concerned. It is probable that, in well-treated cases, the average longevity is not seriously diminished by the disease, especially if the patient is strictly observant of the rules of personal hygiene laid down by the careful physician. The danger to life increases with improper treatment and bad habits, and compounds very rapidly after middle life, because of

arterial and visceral damage inflicted by the active stage of the disease.

When May a Syphilitic Marry?—

Our best authorities assert that, on the average, marriage is safe at the end of three years. Fournier gave these requirements: (1) Present freedom from symptoms. (2) Advanced period of the disease. (3) A considerable period of absolute freedom from symptoms. (4) A mild type of the disease. (5) Prolonged and thorough treatment. (6) Negative Wassermann on repeated examinations, extending over a period of at least a year after systematic treatment has been suspended. In any case, the physician should decline to assume any responsibility. He should merely state the facts, explain the sources of possible danger, and allow the patient to decide for himself.

CONGENITAL SYPHILIS.—**Acquired Syphilis in Children.**—Congenital syphilis should be differentiated from infantile syphilis in general. The course and manifestations of acquired syphilis in children are in nowise different from the same affection in the adult. Children may become inoculated by kissing persons with oral or labial chancre, mucous patches, fissures, or ulcers, or by nursing a syphilitic mother or nurse.

Infection in vaccination must also be remembered, although non-humanized virus is now almost exclusively used, and such an accident occurs only with virus infected by (a) handling by syphilitics in the process of manufacture, (b) unclean hands of the vaccinator, (c) unclean (syphilitized) instruments or dressings during vaccination.

Cases of children infected through criminal assault also have no bearing

upon congenital syphilis, save that great care is to be exercised in differentiation.

The author has reported the case of a boy of 6, who contracted syphilis by sexual contact with a syphilitic girl of 13.

It is held by many that either parent may transmit syphilis to the child, but the question of a father's ability to procreate a syphilitic child without first infecting the mother is still *sub judice*. The presence of the spirocheta probably is incompatible with the life of the spermatozoa. The most plausible view is that, while the presence of the syphilitic germ is necessary in order that the semen should be inoculable, its presence is unnecessary in order that the father should impress the fetus with conditions which, while not specifically syphilitic, are none the less derivatives of that disease. Further Wassermann studies probably will show not only that congenital syphilis is more frequent than hitherto supposed, but also that the father alone is oftener responsible for the infection than has been believed.

Syphilis Hereditaria Tarda.—In a series of lectures at the Hôpital Saint-Louis, Fournier called especial attention to late hereditary syphilis. He reports some interesting cases in support of his view that the first manifestations of hereditary syphilis may be after the period of infancy, and even in adolescence. Experience with the Wassermann test tends to confirm Fournier's opinion.

Lesions of Congenital Syphilis.—If not present at birth, lesions of various kinds develop from time to time. The writer has delivered children with a well-marked roseola. Ero-

sions and excoriations of the quasi-mucous surfaces about the genitals, anus, and mouth are likely to develop, and may form true mucous patches or even condylomata. A "scalded" appearance of the anus is quite characteristic. "Snuffles" develop after a time, and the nares become so obstructed that respiration and nursing are interfered with and nutrition is still further impaired. Ozena may develop and lead to necrosis of cartilages. No symptom is so characteristic as snuffles. Caution is necessary in diagnosis, however. Many young children, especially in such climates as that of our lake-region show a catarrh or coryza exceedingly like syphilitic snuffles.

A livid macular eruption is sometimes seen, and ulcerations may form about the mucous orifices. Papular and pustular lesions are not infrequent, and sometimes quite characteristically affect the palms and soles. Subcutaneous tubercular lesions may be seen in a few cases.

An eruption occasionally occurs that is identical in physical characteristics with ordinary pemphigus in the adult. This "infantile pemphigus" is an unmistakable evidence of syphilis. The bullæ are sparsely distributed. Sometimes but one or two blebs are present. It is especially apt to affect the palms and soles. The fluid varies from turbid serum to pus, sometimes bloody. When the cuticle ruptures, the fluid dries into a greenish crust and ulceration occurs beneath. The author has met with a number of typical examples of this eruption. The hair and the nails are less likely to become affected than in the adult, but a brittle, lusterless condition of the nails occasionally is noted.

Taylor has called especial attention to lesions of the bones, oftenest in the diaphyso-epiphyseal junction of the long bones. The possible dependence of certain cases of rickets upon nutritional perversion incidental to hereditary syphilis is a question of the greatest interest and importance.

The most important manifestations of hereditary syphilis are the lesions of the viscera. Any or all of the viscera may be involved, the connective-tissue changes being especially likely in the liver, spleen, and kidneys.

The permanent teeth in congenital syphilis are irregular, notched, and pegged, and the conformation of the alveolar arch is imperfect. The two upper central incisors are "Hutchinson's test teeth." These are short, vertically notched, narrow, and rounded at their corners.

There is in the syphilitic newborn a marked tendency to apoplectic effusions, particularly in the brain meninges and probably also the cord.

Interstitial keratitis practically is pathognomonic and, if coincident with the syphilitic teeth, puts the diagnosis beyond doubt. The author has had under his care a typical case of keratitis which did not occur until the child was 10 years of age, there having been no previous phenomena of syphilis, save the typical teeth, the significance of which was overlooked.

TREATMENT.—A rational therapy of the disease must necessarily conform to its natural course. Our aim should be to combat its *materies morbi* and reinforce the spontaneous tendency to removal of its results, until the system triumphs. The theory of Ehrlich, that syphilis could be stamped out by sterilizing the blood

with **salvarsan**, revived the old fallacy of the antidotal treatment of syphilis, much to the profit of tyros in syphilology and of commercialists in medicine. Possibly some more experienced, not to say more conscientious heads, also were turned. In any event, **mercury** is still our sheet-anchor. Slow, continuous, and moderate use of mercury, for a period corresponding to the maximum time of the normal duration of the disease as nearly as may be, *without at any time producing its full physiological effects, if it can be avoided*, generally will bring about a cure that can be accomplished in no other way.

It is well known that mercury has the power of inducing fatty degeneration and elimination of inflammatory products, or "of relieving tissues encumbered with superfluous and obstructive material." This condition of the tissues is precisely what exists in syphilis. Mercury should, therefore, be administered throughout the disease, not as antidote, but to remove the morbid results of it as fast as they are formed, until finally the syphilitic impression upon the organism naturally has exhausted itself. Rather peculiarly every method of treatment advocated in two or three centuries—with the exception of **salvarsan**—has comprised such measures as tend to produce rapid tissue-changes, and, more especially, elimination. The **sweating cure**; the use of **hot baths**, as at the **Hot Springs of Arkansas**; the **purgation** and **starvation cures**, Boeck's method of syphilization, and the barbarous treatment by pustulation with tartar emetic, all these are chiefly active through their power of inducing fatty changes in the tissues. **Hydrotherapy** results in

increased elimination. This is especially important in view of the toxins elaborated by the spirocheta.

The action of mercury upon the blood is of great practical interest. Opposite effects may be produced, according to: (1) the doses used, (2) the duration of its administration, (3) the constitutional condition of the patient, and (4) the stage of the disease. (See MERCURY, volume vi.)

If the drug be given in a less vigorous fashion for a longer period, pallor and debility may result, due to depreciation in the red corpuscles, defibrination of the blood-plasma, and increased tissue-waste. A certain degree of these effects is unavoidable; it should be our chief aim to keep them within bounds, and thus avoid permanent injury. Pallor, wasting, debility, pustular or vesicular eruptions, "mercurial fever," and tremors may result from it, without occurrence of the characteristic pyaemia. On the other hand, small doses of mercury, in various cachectic or anemic conditions, particularly during the sequelae of syphilis, stimulate hematogenesis, rapidly improving the quality and quantity of the red cells, and fibrin, thus lessening hydremia. Iodine, until salvarsan came in vogue, was regarded as second only to mercury. The drug still is valuable, more particularly in late syphilis. The iodides—of which **potassium iodide** is the type—act in two ways in syphilis, viz.: firstly by producing fatty degeneration and elimination of morbid products, especially toxins; and, secondly, by liberating, exciting to renewed activity, and eliminating the mercury that is stored up in the tissues, thus assisting its action. The first of these is

the more important, iodides having a powerful effect in resolving the products of inflammatory changes or adventitious deposits, irrespective of their cause. The incorrectness of the argument that iodine can cure syphilis only by liberating mercury from the tissues is shown by the beneficial effects of the iodides in cases of late syphilis in which mercury never has been administered. Since the advent of **salvarsan** some have held that the iodides no longer have a place in the therapy of syphilis. In this the author does not agree. While their range of usefulness is not so wide as before salvarsan they are still of immense value.

Treatment should begin as soon as the diagnosis is established. The duration of the initial lesion is thereby shortened, and secondary symptoms moderated, if not prevented. To save the patient thus from lesions upon the body or face is desirable.

Mercury may be given (a) by the mouth, (b) intramuscularly, (c) by inunction, (d) by vapor, (e) intravenously. In many cases oral administration must be relied upon.

The mildest and least irritating form internally is **mercurous iodide**: the green or protiodide. It is best given in pill form, beginning with doses of, on the average, $\frac{1}{8}$ grain (0.013 Gm.), thrice daily. This dose is continued several days, then increased one pill per day until the gums become slightly tender or the stomach and bowels disturbed. The writer, when the gums are slightly affected, gradually lessens the dose until the patient is taking about half the amount, producing slight physiological effects. This is the patient's average dose—usually from two to

five pills. This generally should be continued—with certain intervals of rest—throughout the course of treatment. It often is well to substitute from time to time some other mercurial.

It is the physician's duty to tell his patient that if he wishes to get well he must take remedies for at least three years, and if any doubt exists at the end of that time he would best add another year, especially if he has matrimonial intentions. In the case of women a still longer period before marriage is advisable than in men.

The patient must be convinced that it is necessary to **avoid liquor and tobacco** for an extended period, and that he must abstain from his accustomed various dissipations and excesses. This point must be insisted upon. Patients who use alcohol and tobacco do not tolerate treatment well, and are prone to develop serious nervous lesions later on. The etiological relation of tobacco to cancer of the oropharyngeal cavity and tongue in late syphilis has been the subject of special study on the author's part, whose belief in its importance is firmly fixed. (*Amer. Jour. of Surg.*, Feb., 1915.)

In some cases **mercurial inunctions** or **mercury-vapor baths** must be wholly depended upon. Both are very efficacious in obstinate skin-lesions. The dissemination of mercurious vapors over the body largely explains the benefit from inunctions.

It formerly was sometimes necessary to bring a patient under mercury very rapidly: *e.g.*, in syphilitic iritis, in which a few hours' delay might be fatal to the eyes. **Calomel**, $\frac{1}{12}$ grain (0.005 Gm.) every hour, accomplished the desired result. If

necessary, ptyalism can be produced thus in twenty-four to forty-eight hours. With the advent of salvarsan this emergency method became obsolete.

Another rapid and efficacious method is **Lewin's method** of hypodermic injection. From $\frac{1}{16}$ to $\frac{1}{8}$ grain (0.004 to 0.008 Gm.) of **mercury bichloride**, in combination with $\frac{1}{300}$ grain (0.002 Gm.) of **morphine** and a small quantity of **sodium chloride**, is dissolved in 15 minims (0.9 c.c.) of distilled water, and injected into the muscles, preferably of the buttock, once or twice daily; a minute dose of **cocaine** may be added.

Taylor used a mixture of **calomel** and **sodium chloride**, 5 parts of each, suspended in 50 parts of distilled water. Of this fluid an ordinary hypodermic syringe-ful may be injected every eight or ten days. The buttocks and the back beneath the scapulae are the best injection sites.

The newer salts of **mercury** have almost supplanted the bichloride and calomel for hypodermic use. The **succinimide** and **salicylate** are best, and should be given at intervals of two or three days to a week, in doses carefully adjusted to the tolerance of the patient, deeply in the gluteal muscles. For emergencies, intravenous injections of **bichloride of mercury** are generally quite as efficacious as salvarsan; further, the beneficial effects are more lasting. Doses of from $\frac{1}{8}$ to $\frac{1}{2}$ grain (0.008 to 0.03 Gm.) dissolved in sterile plain water, or salt solution, may be given daily for several days in some cases. Injections should be made very slowly, and the effects carefully watched. Colitis and stomatitis sometimes follow a single dose. Were it not for

this danger, the author believes that mercury intravenously might advantageously replace salvarsan altogether.

For females with very weak stomachs, and, in children, gray powder—**hydrargyrum cum creta**—is excellent.

It is an almost universal custom to use iodides only late in the disease, chiefly in tertiary lesions; yet many obstinate secondary lesions also yield to the iodides. It is well to give a few weeks' course of the **iodides** from time to time, throughout the course of mercurial treatment. A small amount of the nascent **mercuric iodide** may be added. In precocious syphilis, with early destructive skin and mucous lesions or nerve-changes iodides formerly were our chief reliance. It is in late syphilis, however, that they are most reliable, especially with mercury in the "mixed treatment." Gummy lesions require an excess of the iodides; but, in all cases after the lesions are under control, a prolonged mild mercurial course should be instituted. This is the proper method of treating the deeper lesions of the brain, spinal cord, bones, viscera, and testicle, tubercular lesions of various kinds; the various scaly eruptions; and the later grouped or particularly obstinate syphilides. **Salvarsan** has largely displaced iodine in obstinate lesions in all stages. It should be followed by routine use of mercury.

New Remedies.—Sarsaparilla was long thought to be a specific. Among the new preparations were cascara amarga, berberis aquifolium and stil-lingia, alone or in combination. Experience with these demonstrated their unreliability. As bitter tonics the vaunted vegetable preparations

are all more or less useful, but as specifics they are arrant humbugs. The only valuable addition to our armamentarium is **salvarsan**, or "606."

Having from the first leaned toward the side of conservatism and having waited until personal experience warranted the formulation of conclusions, possibly what the author hereinafter says comes with better grace than if he had received with open arms the new drug as a remedy destined to "wipe syphilis off the map." From careful observation the author is convinced of the great value of salvarsan in meeting the following indications: (1) Prompt removal of severe genital lesions, thus lessening, first, the danger of infecting others; second, the danger of detection; third, local discomfort; fourth, destructive local complications. (2) The prevention or prompt removal of disfiguring skin lesions. (3) Precocious or malignant syphilis and obstinate destructive bone and cartilage lesions, especially of the face and nose. (4) Cases resistant to or intolerant of mercury. In this class of cases salvarsan often is of inestimable service. (5) Early nerve and brain and all visceral lesions, with the exception of renal syphilis. In late nervous lesions its use occasionally—perhaps always—is justifiable. (6) Cases of syphilitic cachexia or anemia, which often consist of a combination of overtreatment and syphilis. (7) Severe and rapidly destructive lesions of the throat and obstinate lesions of the tongue. (8) Syphilis involving the organs of special sense, excepting the retina. (9) Early tabes or exceptionally in late—not terminal—cases in the hope of relieving severe pain or sphincter trouble. (10) Infantile syphilis.

The drug is not promising in most cases of tabes; yet occasional early cases are apparently benefited by it. In the author's own experience there have been cases in which, whether psychic or not, the beneficial results have been enduring for many months, whatever the future may show. The Wassermann test in general is valuable in salvarsan work, but not always necessary. In primary syphilis it is of no service, and in later cases where the diagnosis is clear the

clinical behavior of the cases often makes the Wassermann superfluous at the time.

In certain obviously, or even probably, tertiary conditions, where the Wassermann reaction is negative, we should be governed as to indications for salvarsan by the clinical phenomena. The same is true of obscure nervous manifestations with a clear or even probable history of lues, but with a negative Wassermann.

Mercury alone can cure many cases of syphilis if persisted in, but with arsphenamine active treatment can be greatly shortened and in the very early stages the disease can even be aborted. A positive reaction indicates secondary syphilis, and the disappearance of the positive reaction for six months after mercury has been stopped is evidence of cure. Gibson (Brit. Med. Jour., Feb. 8, 1919).

Contraindications to salvarsan have been advanced. Paresis, advanced tabes, late degenerative brain lesions, acute febrile disturbances, alcoholic inebriety, advanced arteriosclerosis, and organic heart lesions have been accepted as such. The author would lay stress on the danger of salvarsan in renal syphilis. That advanced nerve and brain lesions—unless the retina is involved—are a contraindication does not appear to be a fact. In many of the more serious brain and cord lesions there is nothing to lose and everything to gain, and by using moderate or even full doses we may occasionally do great good. In any event the patient and his friends are entitled to the benefit of the doubt.

In some cases salvarsan is of great diagnostic service, *e.g.*, cases of suspected malignancy, such as lesions of the tongue, where the Wassermann test is negative and the microscopic findings not positive. For many destructive lesions with an obscure history, an absence of spirochetæ, and a negative Wassermann, salvarsan may be not only valuable, but imperative.

Renal syphilis aside, the condition of the kidney is in general most important. Even markedly sluggish renal action is a contraindication for the drug. When actual organic renal disease is present this applies with especial force.

In arteriosclerosis complicating syphilis, the impaired kidney—usually a part of the

cardiovascular pathology—rather than the vascular changes *per se*, renders salvarsan dangerous. Its entrance into the circulation is safe in direct ratio to the rapidity of its elimination. The intramuscular method is here safer than the intravenous, the emunctories not being suddenly overtaxed. Where emergencies are not to be combated, the intramuscular method is more effective, due to the slow absorption and elimination of the drug. Obviously, uranalysis prior to the use of salvarsan often is a wise precaution.

Arsphenamine is generally recognized as of paramount value. Its magical effect occurs because it has a powerful destructive effect upon the spirochete. It likewise has a roborant or tonic effect. Three inunctions of mercury per week is a valuable auxiliary measure, particularly in the primary and secondary stages. No one is in an authoritative position today to state how long the treatment should continue. Too often the physician stops treatment after a single series of arsphenamine injections, and perhaps a course of mercury, because the Wassermann has become negative. This usually requires later resumption of treatment, with valuable time lost. Before any patient is discharged from observation a diagnostic spinal puncture should be made. Schamberg (Penna. St. Med Soc.; Med. Rec., Nov. 16, 1918).

It has been the author's experience that where salvarsan alone is relied upon, and the infection is brought under control, relapses are more frequent and earlier than where the case has been controlled by mercury alone.

Reverting to the value of intravenous injections of mercury, the author recently gave to an early ataxic salvarsan intravenously. At the same time bichloride in $\frac{1}{2}$ -grain doses was given intravenously in a similar case. Both had typical syphilitic histories. The Wassermann test was negative in both; spinal fluid not examined. The result from salvarsan was negative. Improvement in the mercury-treated case was marked after the first injection and, after three injections, astonishing.

Method.—In general, the intravenous method of administering salvarsan is best for emergencies; it is least annoying and least painful in all cases. The intramuscular method sometimes apparently gives better results where speedy action is not indispensable. It is, however, more painful, and in expert hands not so simple.

Technique.—The author's aim has been to simplify and decommercialize the technique of the salvarsan treatment. The smaller the bulk of menstruum within the limits of safety, the better. Absolute asepsis is necessary.

For intramuscular injection, either the lumbar portion of the erector spinae or the glutei should be selected—preferably the latter. For the intravenous method any accessible vein will do, the median basilic or median cephalic preferred. The skin is prepared in the usual manner and then painted with tincture of iodine. In the intravenous method, the vessel may be exposed by incision, if necessary—as it very rarely is, oftener in women than in men. Care should be taken not to apply the tourniquet too tightly, else the arterial supply will be cut off and the veins made less prominent. A needle for the intravenous method should not be larger than 21 or 22; that for the intramuscular should be about No. 18.

For the intramuscular method the author prefers suspension of the drug in iodized oil of sesame, 10 per cent., rubbing up the mixture thoroughly with mortar and pestle. From 3 to 6 c.c. are injected, half upon each side of the spine or glutei. The needle should be detached from the syringe before injecting to ascertain whether or not a vessel has been punctured. If so, a new puncture should be made. Gauze, or cotton and collodion, serves as a dressing.

The degree of local reaction from the intramuscular method varies. Some patients are glad enough to keep quiet for several days; others refuse to lay up for more than a few hours. Some of the latter regret their obstinacy a day or two later. There is occasionally a slight rise of temperature.

Sometimes, after absence of immediate reaction, tenderness and pain at the site of intramuscular injection and a rise of tem-

perature, after both intramuscular and intravenous methods, develops later. This pertinently suggests advisability of rest for several days in most cases.

For the intravenous method the author employs the **neosalvarsan** via a Luer syringe, using only 10 c.c. of sterile salt solution, mixing the dose in a mortar. A gauze dressing completes the operation.

Local reaction following the intravenous method means one or several of the following: (1) Infection. (2) Injection of the fluid into the circumvascular cellular tissue. (3) Injection of vein wall. (4) Transfixion of vein. (5) Too rapid injection.

Case of laryngeal syphilis which, in spite of intensive antisymphilitic treatment for years, suddenly became dangerously progressive. **Intravenous injections of sodium iodide** were begun, increasing by 5 grains (0.3 Gm.) from 30 up to 335 grains (2 to 22 Gm.). The treatment was remarkably well borne. Mercury and arsphenamine were likewise administered to the limit. Within a few weeks, improvement was obvious. This patient received 125 injections, or 26,013 grains of sodium iodide, in 8 per cent. solution. Howard (*Amer. Jour. of Syph.*, July, 1918).

Instead of arsphenamine, **galyi** was used intravenously in 28 cases, 0.2 Gm. being given at intervals of four or five days. After the fourth injection the Wassermann was usually negative and continued so. The injections were then given at five- or six- day intervals, up to 2 Gm. Reactions were slight. Small chancres healed in four to eight days; phagedenic chancres, in twenty-five to thirty days. In cases treated from the outset no roseola or mucous patches developed. P. Richard (*Can. Jour. of Med. and Surg.*, Sept., 1918).

Local Treatment of the Chancre.

Important in this connection is (1) to avoid caustics, (2) to avoid grease, and (3) to keep the parts as dry as possible and perfectly clean. Important in severe chancre is the maintenance of rest. Movement and fric-

tion are often responsible for serious complications. Sexual intercourse should, of course, be interdicted.

The only exceptions to the rule regarding caustics are mixed sores, with a minimum of induration, and exulcerated sores that become sluggish and refuse to heal after induration has nearly or quite disappeared. In the first instance pure **carbolic acid** followed by **fuming nitric acid** is admissible, but the **galvanocautery**, preceded by **cocaine**, is better. In sluggish ulcers stimulation with **silver nitrate** may be warrantable.

The old-time **black** and **yellow washes** are serviceable, although the part cannot be kept dry under their use. A solution of **mercuric chloride**, 1 to 20,000, is very useful. A plan

recommended for the application of the **bichloride** is to wash the lesion with a weak solution of common salt. **Calomel** is now sprinkled upon the part, a small amount of nascent and active bichloride being thus formed. The writer has used this plan for condylomata quite successfully. The best absorbent for the dry treatment is the powdered **oleate** or **stearate of zinc**. Simple **calomel** is also useful.

Once the diagnosis of true chancre is made, local treatment usually is of but little importance. As a rule, **salvarsan** or intravenous injection of **mercury** quickly causes the lesion to disappear.

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SYRINGOMYELIA. See SPINAL CORD, DISEASES OF.

T

TABES DORSALIS.—Locomotor ataxia; posterior spinal sclerosis.

DEFINITION.—Tabes dorsalis is an organic disease of the periphero-central sensory nervous system characterized symptomatically by inco-ordination, sensory and trophic disturbances; affections of special nerves, the optic and ocular particularly; and involvement of the sphincters.

VARIETIES.—The symptom-complex, in its classical form, is exceedingly constant. But variations occur in the clinicopathological picture which justify classification into at least three types: the common, or *typical*; the anomalous, or *atypical*; and the *complicated*.

In the first type, or typical cases, the symptoms point to a primary disease of the sensory neurons of certain

areas of the lower dorsal and lumbar cord (common type). Rarely, the primary invasion is of the upper cord (cervical or superior tabes), and in still others the initial symptom may be an optic atrophy (amaurotic tabes, initial optic-atrophy type). The predominance and persistence of pain in certain cases has served as the basis for a so-called neuralgic type (tabes dolorosa, Remak), while the early development of general or pseudoparalytic muscular weakness is a basis for the "paralytic" type. True motor paralysis is not an essential part of tabes, however, except as a late secondary phenomenon. Occurring early, it indicates the existence of a complication. Erratic extensions of the disease into other areas of the cord give rise to anomalous symptoms (see Complications, p. 488).

SYMPTOMS.—*Tabes dorsalis* may be divided into at least two symptomatic stages: the incipient, or preataxic, and the ataxic. The line of demarcation is so indistinct as scarcely to justify separate consideration, and I shall therefore first describe the clinical history as a whole.

Analyzing 500 cases of *tabes*, progressive paralysis or cerebrospinal syphilis, the writer found 78 cases of the abortive type. Only 46 of these had pronounced symptoms. In 32 there were merely reflex rigidity of the pupil and disturbance in the sensibility, usually in the legs. In none was there any trace of lancinating pains. In a few there was isolated ataxia of the legs. He never encountered a case in which there were crises alone for years without other signs of certain *tabes*. P. Schuster (*Med. Klinik*, May 4, 1913).

Tabes begins very insidiously, and its early progress is usually slow. The first subjective evidence may be numbness or other paresthesiæ (tingling, burning, "pins and needles," etc.) occurring in the extremities, or, more frequently, attacks, occurring paroxysmally and without warning, of sharp stabbing pains, usually in the legs, but without constancy as regards distribution.

Pains are the most important indication of the commencing sclerosis and may be the only dominant or even apparent symptom for perhaps even ten or twelve years. A. McL. Hamilton (*N. Y. Med. Jour.*, Feb. 22, 1913).

The lightning pains of *tabes* enable the physician at times to make a diagnosis before the other symptoms have appeared. These pains are characteristic. They stab like a knife, or a darning-needle going in, or they resemble the effect produced by taking up the flesh, pulling at it, and letting it go. The pains come not singly, but rapidly repeated, several occurring in the course of a second or

two, followed by a lull of longer or shorter duration. Buzzard (*Lancet*, Jan. 8, 1921).

Slight diminution, or, rarely, sudden increase in sexual desire or power may be noted about the same time.

Fatigue from exercise, as in walking, dancing, or the ordinary occupation, is greater in degree and occurs more quickly than before.

Transient attacks of double vision may be noted with or without ptosis. The normal action of the bladder and sometimes of the rectum may be disturbed. Severe attacks of rectal neuralgia sometimes occur quite early. The knee-jerks are decidedly diminished in activity or even abolished (Westphal's symptom). Tests of sensation may reveal an impaired tactile perception in the distribution of the ulnar nerve (Biernacki), the peroneal (Sarbo) or the popliteal space (Bechterew), or over the plantar surfaces of the feet.

Anesthesia in the region of the nipple, usually bilateral, is referred to as Patrick's sign.

The eyes will present the Argyll-Robertson pupil, which consists in a loss of the reflex to light, although accommodation to distance is preserved. The pupils are often quite early found abnormally contracted, sometimes to the degree of "pin-point" pupils. They may be unequal.

The palsies of eye-muscles possess certain peculiar characteristics. One is their transient tendency, especially in the early stages of the disease. A history of diplopia can often be elicited. There is a marked disposition to recurrence. The palsy may last only a few hours or persist for years and the return of the muscle to normal action even after long periods should be recognized as a possibility in tabetics and tend to discourage

operation in such cases. Posey (Jour. Amer. Med. Assoc., Apr. 16, 1910).

Atrophy of the oculomotor nerve is one of the earliest symptoms of tabes but occurs seldom in syphilis. Syphilitics with recurrent attacks do not become tabetics. Fuchs (Wiener klin. Woch., Apr. 4, 1912).

The writer's spinal sign consists of a point or small area of tenderness just to the left of the spinal column, corresponding to the fifth dorsal interspace or one at about that level. It is always to be found on the same side as the stomach. It may occasionally extend to more than one space. It rarely involves the other side, and then only in minor degree. An evident wince on the part of the patient or an expression of pain shows when the tender spot is reached. Browning (Med. Rec., Oct. 30, 1920).

The disease may remain practically stationary at this stage for some time, even for years (Gray), but sooner or later symptoms of ataxia supervene. Ordinarily the ataxia is first noticed in walking at night or along a narrow pathway or in circumventing obstructions. Previously automatic action in walking, standing, dancing, etc., demands more conscious attention. Quite early, the patient will present the Romberg sign, by which is meant an inability to stand without swaying or falling if the feet are placed close together. Minor degrees of this are sometimes shown only with the eyes closed or by having the patient attempt to stand on one foot. In walking the ataxia is manifest in the increasing difficulty with which the patient follows, heel and toe, a chalk line or a carpet-seam or crack along the floor. Here, again, closing the eyes greatly intensifies the difficulty.

Obersteiner lays stress on the import of inability to walk backward. I have for many years employed this

test in examining tabetics, and have frequently noted with curious interest that the patient could walk backward with less ataxia than forward.

The gait becomes characteristic; the feet are kept wide apart, are lifted unnecessarily high, and are brought down to the floor with an appearance of unusual and unnecessary force, the heel striking first. Charcot is quoted as stating that he often made the diagnosis from hearing the patient's footfalls, before having seen him at all. The patient will often state, in explanation of his defective gait, that he is losing power in the legs. Attempts at forced flexion or extension, the patient resisting, will show, however, that muscular power is intact.

The ataxia may extend—in the cervical cases it begins—into the upper extremities. The pianist loses his delicate technique, the machinist his dexterity. Fastening a button, especially when not in the field of vision, becomes a serious problem. If asked to touch the tip of his nose with the tip of his finger or to bring his outstretched arms together so as to touch the tips of the right and left forefingers, the eyes being closed, the patient will almost invariably fail. Later, these symptoms are intensified and others added, chiefly sensory. The patient complains of a feeling of pressure or constriction or band of numbness round the waist, chest, or throat.

Various disturbances of the viscera may develop. Attacks of apparently causeless vomiting, of gastric pain, of dyspnea, of palpitation, of vesical or rectal tenesmus occur which are known as crises. Certain trophic alterations in the skin, hair, and nails may be present, or the teeth may fall

out gradually and painlessly. The joints, especially the knees and elbows, sometimes enlarge suddenly, as a rule, without pain, constituting the so-called tabetic arthropathies of Charcot. The bones become easily friable. Abnormalities in the visual apparatus again become conspicuous.

The transient strabismus or ptosis of the earlier stage may recur and become permanent. The optic nerve presents the symptoms of atrophy, and total blindness may result, often quite early in the disease.

All forms of common sensation become impaired in varying degrees and different localities. An analgesia develops, which may be absolute, but is more often partial and frequently ataxic. The patient, pricked on the left leg, may refer pain to the right (allochiria) or to both legs. This phenomenon is sometimes true, also, of tactile and temperature perception. Pain-conduction may be retarded or delayed. Several seconds may intervene between the actual pinprick and the patient's appreciation of it.

The muscular sense is invariably impaired in some degree and in nearly all of its subdivisions—position, weight, pressure, etc. If the eyes are closed the patient may not be able to tell whether a given muscle or set of muscles is being flexed or extended, pronated or supinated, by the examiner. If two wooden globes, of like size, but differing in weight, are placed in the hands of the patient, he cannot distinguish the heavier from the lighter. Pressing unequally with the hands upon the patient's thighs or other symmetrical parts of the body, he is unable to distinguish the inequality. Variations in the degree of contact heat or cold

are not appreciated. Finally, a condition of motor helplessness or paresis may be superadded.

Several variations in the picture may occur. The disease may begin with an initial ataxia; it may begin with an optic neuritis or atrophy. In rare instances the earlier symptoms are referable to lesions in the cervical cord, the upper extremities being first affected. Such cases are known as cervical and sometimes as superior or descending tabes, though the two latter terms have also been applied to general paresis with secondary posterior spinal sclerosis. Painful sensory phenomena are sometimes very marked, persistent, and widespread. The shooting, stabbing, grinding pains in the legs, the rectal pains, the trigeminal pains, the painful crises, may be all extreme and give rise to the "neuralgic" type. If the disease develops within a year or two after primary syphilis, the picture takes on the bizarre characteristics of exudative nervous syphilis.

Symptomatic Analysis.—*The Reflexes.*—One of the earliest—possibly the earliest demonstrable—symptom is a lessened patellar-tendon reflex. This diminution may be first unequal on the two sides, but later both knee-jerks are eventually lost (Westphal's symptom). So constant is this symptom as to have been held pathognomonic. It may even occasionally exist in persons otherwise healthy. Some investigator has stated that 2 per cent. of normal individuals show absence of knee-jerks.

The simplest diagnostic method is to have the patient "cross" the leg carelessly, when, with the side of the extended hand or a percussion-hammer, a sharp tap over the tense

patellar tendon will ordinarily demonstrate the normal or exaggerated presence, or the loss, of the reflex. Such a test, however, is not final unless practised with one of the methods of sensory or mental reinforcement, the simplest of which is Jendrassik's. This consists in having the patient grasp the hands tightly and look up at the ceiling, or at least away from the field of examination, as the tendon is struck.

While abolition of the knee-jerk is exceedingly constant, occasional examples of the disease have shown the reflex preserved and intact. The explanation is found in non-involvement, by the disease-process, of the zone of entry (*Wurzels eintritt*) of the corresponding posterior roots. Hemiplegia in a tabetic patient may result in return and even exaggeration of the knee-jerk.

Case of tabes dorsalis suggestive of Friedreich's ataxia. The patient was a man, about 28 years old, who presented ataxic gait and station, absence of knee-jerks, insignificant ocular changes, and high foot-arches. There was no history of similar disease in the family and the Wassermann reaction was negative. J. H. Lloyd (Med. Rec., Nov. 21, 1914).

Mills, following the observations of Babinski as to the significance of the tendo-Achillis jerk in tabes, thinks that this sign may prove of value in removing the element of doubt in cases in which the knee-jerk is preserved, such cases usually showing alteration of the Achilles-tendon jerk.

In early tabes the cutaneous and superficial reflexes are preserved and may be exaggerated: a fact of some diagnostic significance (Bechterew). In the late disease these also are lost.

There are cases in which the knee-jerks persist, at least for a time; in others they return after having been absent; in some the Argyll-Robertson pupil is wanting; in others it returned after having been absent. In some there is return of sexual power previously wanting, especially after treatment with **testicular extract**. J. K. Mitchell (Med. Rec., May 31, 1913).

Pupillary Symptoms.—Fixed pupillary contraction (spinal myosis); a loss, abruptly or gradually progressive, of the reflex action to light; accommodation to distance and in convergence being preserved (reflex iridoplegia, Argyll-Robertson pupil) with loss of the sympathetic skin-reflex, are the more constant and characteristic pupillary abnormalities in tabes. Both eyes are usually affected and to about the same degree. The iridoplegia may be unilateral, however; and the two pupils may be unequally contracted or one only may be abnormally small. Permanent mydriasis or dilatation is rare.

I have noted an inconstant iridoplegia in two women with tabes, in both of whom the phenomenon appeared and disappeared several times. In another patient, a physician, the iridoplegia was unilateral for several years, during which time loss of knee-reflex and plantar anesthesia was also unilateral and of the same side.

The Argyll-Robertson pupil is, perhaps, the most constant and characteristic symptom in posterior spinal sclerosis. It is also an early symptom invariably, and with abolished knee-jerks justifies a diagnosis even in the absence of all other symptoms. In late tabes the action of the pupils in accommodation is also lost.

The lesion in Argyll-Robertson

pupil is probably in the fibers which pass from the proximal end of the optic nerve to the oculomotor nerve, according to de Schweinitz, who quotes Turner, however, as believing that a single lesion in the forepart of the oculomotor nuclei in the Sylvian gray is the cause of both myosis and reflex iridoplegia.

The eye findings may exist years before tabes becomes manifest in any other way. It is necessary to detect it and apply treatment before irreparable lesions are caused. Eye examination does this by revealing the first tendency to loss of reflex contraction of the iris to light. Only part of the iris at first fails to contract. Any irregularity in the circumference of the iris as it contracts warns of beginning impairment of the light reflex if there is relative miosis and the contraction of accommodation proceeds normally. By this means we can diagnose incipient tabes with certainty when but a few of the cells and fibers involved are affected. Behr (Med. Klinik, Dec. 27, 1914).

Optic Atrophy.—This may occur at any stage, though usually present early, and is found in from 10 to 35 per cent. of cases. Bergur found it present in 44 of 109 cases. Disturbances of color-sense and contraction of the visual field are associated. Atrophy is usually slow, and remissions may occur. Blindness ensues in from three to five years. The ataxia and also the painful sensory symptoms diminish upon the onset of blindness, as a rule (amaurotic tabes). The left eye is said to be attacked oftener than the right. Usually both are involved.

Ophthalmoscopically the optic atrophy has the appearance of primary degenerative atrophy in contrast to the appearance in that form which follows neuritis.

Ocular-Muscle Palsies.—One of the first symptoms in locomotor ataxia may be an attack of double vision with or without ptosis. Occurring early, such attacks are usually abrupt and of short duration, disappearing completely in a few days or weeks. Well-marked strabismus, most commonly of the variety due to sixth-nerve involvement, may be present, and, if early, is equally abrupt and transient. Möbius believes that sudden painless ocular palsies in an adult are almost pathognomonic of tabes. They are certainly exceedingly suggestive. Ptosis, more or less decided, is frequently noted in the late stages. It is usually slow in development and remains permanent, as does also late strabismus. Ophthalmoplegia, both external and internal, has been infrequently observed.

Normally, compression of the eyeball is followed in two or three seconds by a diminution of the rate of the heart-beat to the extent of eight pulsations per minute. This reflex is abolished in tabes. The absence of this reflex has the same significance as the Argyll-Robertson pupil. M. Loeper and A. Mougeot (Prog. méd.; Med. Rec., Feb. 14, 1914).

Ataxia.—The disease may manifest itself first in an ataxia of gait or station (acute locomotor ataxia). But usually various sensory and other symptoms prominently precede the ataxia, disturbances of co-ordination being essentially dependent upon impaired centripetal or sensory impressions. Loss or defect of muscular sensibility, particularly of position-sense, is the chief cause of the ataxic gait and inco-ordination of upper limbs. Romberg's symptom is probably due to the associated involvement of both tactile and muscular sensibility. Ley-

den's experimental induction of this symptom by freezing (anesthetizing) the soles of the feet with ether-spray demonstrates at least some participation of the tactile sense. Helplessness from ataxia should be carefully distinguished from helplessness due to true motor paralysis or paresis.

Suspicion of tabes should be aroused in children when they show persistent migraine, tendency to spasmophilia, enuresis, simple transient "absences" (abortive epileptiform seizures), inability to keep up with the class in school, tics, slight choreic instability, visual disturbance, or cramps in one limb. Lereboullet and Mourzon (Paris méd., Jan. 4, 1919).

Tabetic Crises.—These consist of attacks, occurring suddenly, without assignable cause and ending quite abruptly, as a rule, simulating attacks of gastric, intestinal, nephritic, vesical, or hepatic colic. Gastric crises are most common. The patient is suddenly seized with excruciating gastric or abdominal pain, usually with violent retching and vomiting. The attack may last two or three days or it may end after a single paroxysm lasting a few minutes, recurring at varying intervals from a week to several months. Except from malnutrition, such attacks are not dangerous.

Study of 42 cases of tabes with gastric crises. The patients were all males of 29 to 64 years. The crises were noted five times as an initial symptom. Severe pain was noted in 11 cases, was moderate in 9 cases, and severe and sometimes moderate in 22 instances. Severe attacks of vomiting were observed in 23 instances, moderate in 12, and severe and again moderate in 7 cases. The gastric secretion was obtained during the crises of 35 patients; it contained a normal amount of acid in 6 cases,

while hyperchlorhydria existed in 13; hypochlorhydria was present in 10, and variable acidity in 6. The secretion was secured during intervals in 36. There was normal acidity in 14, hyperchlorhydria in 12, and hypochlorhydria in 10. Friedenwald and Leitz (N. Y. Med. Jour., July 6, 1912).

The authors found in the post-mortem records of the General Hospital of Vienna 5 cases of ulcer and 3 of carcinoma of the stomach in 75 tabetics. All but 1 had gastric crises. In 6 cases at operation either a fresh or healed ulcer of the stomach was found. From these, and rabbits in whom bilateral vagotomy invariably causes an ulcer of the stomach, they conclude that the ulcer in tabetics is due to a lesion of the vagus nerves. Histologically, profound changes were found in all cases examined. A. Exner and E. Schwarzmann (Wiener klin. Woch., Sept. 19, 1912).

The proof of the connection between gastric disturbance and spinal lesion often depends on signs of which the patient is unaware—such as faulty reflexes and cutaneous sensibility, and changes in the spinal fluid; the demonstration that active syphilis exists by the Wassermann reaction in the blood and spinal fluid, or even in the latter alone, adds the last link to the chain. W. F. Cheney (Amer. Jour. Med. Sci., Mar., 1913).

When, however, the heart's action or the functions of respiration are involved, the danger is much greater, fatal results having been recorded. Both varieties, fortunately, are rare. The symptoms in *laryngeal crises* are not unlike those of laryngismus stridulus: dry, violent cough, with spasmodic inspiration, marked dyspnea, and at times unconsciousness. Burning pains in the neck- and shoulder- muscles sometimes occur.

In one of my patients, subject to laryngeal crises, a total aphonia repeatedly occurred, lasting from a few

ments to several hours. This patient later developed minor epileptiform attacks, dying finally in a "status" of such seizures.

Cardiac crises resemble attacks of angina pectoris. There may be actual disease of the heart of trophic origin. A rapid pulse—100 to 120—was often noted in Charcot's cases without associated cardiac crises.

The crises of tabes possess a localizing pathological value quite analogous to that of the aura or signal symptom in epilepsy, pointing to an invasion and irritative degeneration of the vagus-nuclei or fibers, or to fibers elsewhere physiologically related to the symptoms. Crises are among the earlier clinical phenomena usually, but they may persist for many years. They often ultimately disappear with the lancinating pains.

Sensory Symptoms.—The defects in common sensations have been sufficiently described. Among less frequent sensory phenomena are analgesia of the testicle and anesthesia in the distribution of the fifth nerve, especially over the mucosæ of the mouth and eyelids.

In tabetic ataxia there is abnormal perception if the skin is pressed with the finger and pushed in various directions or a fold is taken up in the fingers and pulled up or down or sideways. A healthy person can always tell in which direction the movements are made, but the tabetic is often or constantly mistaken. Baeyer (Münch. med. Woch., May, 1914).

Pitres found analgesia of the testicle in 75 per cent. of his cases. It varies in degree from time to time and may disappear temporarily. Its disappearance may coincide with a return of sexual power. The sharp,

stabbing, vagabond pains of locomotor ataxia are so distinctive in character as to be unique. No two patients will, perhaps, describe them in the same way, and yet their identical character is at once evident from descriptions. They are often worse at night and during excessive humidity presaging a storm. Tabetics are often, indeed, quite reliable weather prophets.

Trophic Symptoms.—Some degree or variety of trophic disturbance is usually manifest at some time, not as complication, but essentially as a part of the disease. Occurring early, the trophic changes are due to involvement of the peripheral trophic sensory fibers; late trophic symptoms may be dependent upon lesions of the ventral horns. Among the trophic symptoms are superficial and perforating ulcerations of the skin and other cutaneous lesions, loss of the hair or teeth, onychia; atrophies of muscles, singly or in groups; nutritional disease of the bones, particularly the femur, giving rise to spontaneous fractures; arthropathies, with secondary luxations and displacements; edema; bed-sores.

Perforating ulcers almost invariably develop on the plantar surfaces of the feet, often beneath the great toe, and may be symmetrical. Such ulcers may occur early. In one of my patients such ulcers led to the discovery of tabes, the discovery overwhelming him with surprise.

Herpes is not an uncommon accompaniment of the severe neuralgic or neuritic pains sometimes observed. Baldness or anomalies in pigmentation, especially the former, are common. The teeth may all fall out as a result of trifacial involvement.

Onychia is sometimes very troublesome, and wounds or operations upon the extremities, especially the feet, may prove quite obstinate in healing. Muscular atrophy, if extensive, is a late incident. Extensive atrophy occurring early indicates a probable complication. Atrophy of single muscles may occur, though seldom early, as a result of neuritis.

Extreme widespread emaciation has been noted. In two such cases under my observation frequent, severe gastric crises caused death.

The arthropathies and osteopathies of tabes occur in from 5 to 10 per cent. of cases. The knees are chiefly affected. The smaller joints usually escape, though Hirtz has reported a case with radiographic illustrations, involving the metatarsophalangeal articulations. In some cases there exists, without swelling or deformity, a remarkable relaxation of the muscles of the knee and other joints, permitting extreme hyperflexion and hyperextension. This condition has been called "hypotonia" by Fränkel, who considers it an early symptom.

Röntgen-ray findings show that an extensive destructive and a proliferating process run their courses together and lead to abnormal bone growth outside of the capsule. The whole trouble frequently begins with an erosion of the bone; this is often distinctly evident in the Röntgen picture. Krüger (Mittel. a. d. Grenzgeb. der Med. u. Chir., xxiv, nu. 1, 1912).

History of 23 cases of tabes in which Charcot joints and spontaneous fractures were, in some, the earliest symptoms. They often precede the ataxic gait, and are of diagnostic importance in tabes. Charcot joints are frequently of traumatic origin and often follow fractures and lesser injuries. H. L. Taylor (Jour. Amer. Med. Assoc., Nov. 15, 1913).

Attacks of edema in the extremities or elsewhere, usually transient and of a type similar to angioneurotic edema, have been noted. Bed-sores on the sacrum, over the trochanters, etc., ordinarily belong to the bed-ridden stage. An emphatic protest is made against the custom for relieving leg pain, of tightly binding a cord or ligature around the limb. It may, and sometimes does, effectually relieve the pains, but at great risk of inducing far more serious trophic disturbances.

Vesical, Rectal, and Sexual Symptoms.—Slight incontinence or slowness in micturition may first attract attention to the possibility of tabes. This may vary from time to time, and is rarely extreme or particularly annoying. In the late stages there may be partial or total anesthesia of the bladder, with either absolute incontinence or retention. The urine may be retained without discomfort for many hours, and, unless withdrawn by catheter, a cystitis may develop. Catheterization should be practised very carefully in such cases.

The initial symptoms of tabes may be urinary incontinence, and strongly resemble those of prostatitis and vesical calculi. Having these possibilities in mind, the surgeon should approach every supposedly renal, vesical and prostatic case with the greatest possible circumspection. H. Klussman (Pacific Med. Jour., Dec., 1911).

Tabetics are almost invariably constipated, although in the advanced disease incontinence of feces may be present. The rectal region may be the site of sharp, stabbing pains in neuralgic cases. Sexual desire and power, while invariably impaired or abolished in the advanced disease, is

sometimes at first exaggerated, the patient committing the grossest excesses in sexual intercourse. Such paroxysmal satyriasis may give way to total temporary abolition of sexual function. The cremasteric reflex is said to return and the scrotal anesthesia to lessen with each return of function.

Special Senses.—In addition to vision, hearing is affected in about 75 per cent. of all cases. Deafness is rarely due to atrophy of the auditory nerve, and sometimes to a trophosclerotic condition of the middle ear through trifacial involvement.

Taste and smell are believed to be rarely affected, though Klippel does not agree with this view.

They are, moreover, among the earliest symptoms in tabes, according to this author, who describes a case with these symptoms, which came to autopsy, showing marked degenerative disease of the olfactory, glossopharyngeal, and trigeminal nerves and their ganglia.

DIAGNOSIS.—The chief diagnostic problem lies in the prompt recognition of the incipient or preataxic stage. No single symptom is pathognomonic, although the Argyll-Robertson pupil is considered by Möbius and others as invariably indicative of either locomotor ataxia or general paresis. The conjoint association of any two of the four most constant symptoms—abolished knee-jerks, Argyll-Robertson pupil, lightning pains, and ocular palsies—is quite suggestive, if not diagnostic. Coexistence of the four symptoms is positively diagnostic. Subsequent development of ataxia completes the unique clinical picture.

Among the diseases obscuring the

diagnosis, are ataxic paraplegia, disseminated sclerosis, brain-tumors, certain forms of myelitis; the syphilitic meningomyelitis of Oppenheim and others; multiple neuritis, and postdiphtheritic paralysis.

In the **ataxic paraplegia** of Gowers there is actual loss of motor function with spasticity, the knee-jerks being usually exaggerated with little if any pain, no crises, no arthropathies, and no involvement of the eye-muscles.

In **multiple sclerosis** there may be ocular palsies, pains (slight) in the lower extremities, defects of sensation, sphincteric involvement, ataxia, and even abolished knee-jerks. The knee-jerks are usually exaggerated, however; the pains differ in degree and character, and the peculiar speech, intention-tremor, nystagmus, and special variety of optic atrophy (Gnauck) are distinctive.

Ataxia is common in **tumor of the cerebellum**, the frontal lobes, and the base of the brain. Optic atrophy and ocular palsies are also frequent. Attacks of vomiting may simulate gastric crises. The clinical picture and history of focal palsies, headache, hebetude, etc., in **brain-tumors** serve to distinguish the two conditions quite readily. In **myelitis** the absence of optic atrophy, ocular palsies, and Argyll-Robertson pupil suffice to eliminate confusion. In **multiple neuritis** the deep reflexes are abolished or diminished, there may be much pain, and the ataxia may be decided. The rapid atrophy and true motor weakness, with altered electrical reactions, absence of pupillary changes, and preserved light-reflex are diagnostic. **Postdiphtheritic paralysis** simulating tabes is a multiple neuritis, and the differential data are

the same. In syphilitic meningomyelitis there is, at times, a close resemblance. In such cases, however, motor as well as sensory defect is present, the symptoms are unilateral or at least unequal in degree on the two sides, the Argyll-Robertson pupil is not present, and prompt improvement nearly always follows the energetic use of potassium iodide and mercury.

Cervical tabes is at times difficult to differentiate from syringomyelia: a fact especially emphasized by Marie. Cervical tabes is rare, Déjerine finding only 1 in series of 101 cases.

Psychical disturbances in tabes are not quite so rare, according to Obersteiner, as is usually believed. One must carefully guard against confounding them with a condition of dementia paralytica combined with ataxic symptoms.

All cases of gradually progressive blindness—if dependent upon optic atrophy and especially if occurring in negroes—should excite suspicion and lead to careful examination for other symptoms of tabes.

Laboratory methods in the diagnosis of all suspected luetic diseases of the central nervous system, including tabes, have come into general use as a routine procedure. A positive Wassermann is found in about 70 per cent. of all cases. A negative Wassermann is, however, of no significance in the face of a clinical diagnostic syndrome. A lymphocyte count of 50 or more to the cubic millimeter is considered absolutely corroborative. Globulin reaction occurs in about 90 per cent. (Noguchi). The colloidal (gold) test of Lange is also quite a constant finding.

Of 1000 tabetics, 8.7 per cent. had been subjected to laparotomy and, mistaken diagnoses one or more times, chiefly through failure to examine the nervous system. A history of paroxysmal attacks of vomiting, rheumatism, paresthesias, bladder disturbances, or fractures without physical violence should excite interest to exclude tabes. Cerebrospinal cytodiagnosis and the spinal Wassermann are of inestimable value in doubtful cases. Nuzum (*Jour. Amer. Med. Assoc.*, Feb. 12, 1916).

One of the earliest pathologic changes in tabes is a syphilitic leptomeningitis of the cord on its posterior aspect. This induces a multiple symmetrical radiculitis with pain and paresthesias; impairment of superficial and deep sensibility; loss of the Achilles reflex; increased spinal cell count and globulin content, and a positive spinal Wassermann. Other very early signs of tabes are anisocoria, pupils of irregular contour, and diminished hearing. Cardiovascular disease, especially aortic, and general glandular enlargement are very constant early signs. Schaller (*Jour. Amer. Med. Assoc.*, Jan. 20, 1917).

Case of tabes from congenital syphilis in a boy of 15. Under treatment most of these subsided. Two similar cases are also referred to. Suspicion of tabes should be aroused in children with persistent migraine, tendency to spasmophilia, enuresis, simple transient "absences" (abortive epileptiform seizures), inability to keep up with the class in school, ties, slight choreic instability, visual disturbance, or cramps in one limb. There was no disorder of gait in the case reported. Lereboullet and Mouzon (*Paris méd.*, Jan. 4, 1919).

ETIOLOGY.—Heredity is of very minor importance, if, indeed, it is a factor at all in the etiology of tabes.

The writer observed tabes in brother and sister. All cases of this kind are due to inherited syphilis. We should examine carefully the relatives of tabetic subjects for the

stigmata of tabes incipiens. Heitz (Paris méd., Apr. 13, 1912).

The same is true of diathetic states, although a rheumatic predisposition may possibly favor its development.

The writer believes that functional anomalies and disturbances of the endocrinous glands constitute a factor of importance in explaining individual predisposition. Starkey (Med. Record, Mar. 4, 1916).

Next to syphilis, the occupation and habits as regards excesses, particularly physical, are most important.

Railroad employes (especially engineers), soldiers, sailors, policemen, lumbermen, drivers, and others whose work combines exposure to wet and cold, with severe physical exertion, are quite numerous among the victims of tabes. Excesses in athletic sports, in dancing, and in sexual intercourse are all considered adequate predisposing or even exciting causes when combined with syphilis.

Traumatism to the spine by direct violence or concussion, as from a violent fall on the feet, has been, in some instances, the only apparent cause.

Three cases in which tabes had developed apparently immediately after a trauma, but the investigations showed that it must have existed before the accident. The latter did not have even an aggravating effect in 2 cases; in the third case the new symptoms that developed after the trauma were localized in the part specially injured. This case was further complicated by a traumatic neurosis. There was no history of syphilis in any case and the Wassermann test was negative. Schultze (Berl. klin. Woch., Nov. 4, 1912).

Of all the etiological factors, syphilis appears most constantly. Many believe that tabes implies pre-existence of syphilis. This is, probably,

an exaggeration; but a history or collateral evidence of syphilis can be elicited or demonstrated in more than 75 per cent. of all cases. Erb found 89 per cent. in 300 private cases. The exact pathogenetic relationship has been until recently vague and conjectural. The actual demonstration by Noguchi and Moore (1912 and 1913) of the spirocheta in the brain and cord in paresis and tabes led to acceptance of the direct causative relationship of syphilis to these conditions.

Of 151 female tabetics, 14 were unmarried women; 11 of these had a history suspicious of syphilis, but 3 others were virgins. It was ascertained, however, that one or both of the parents of these three virgins had had syphilis and tabes, so that the tabes was due to an inherited taint in each one. Mendel and Tobias (Med. Klinik, Oct. 22, 1911).

The interval between infection and tabes is sometimes thirty years or more. On the other hand, I have seen well-marked tabes in a patient who was under energetic treatment for cutaneous syphilis, infection having occurred less than eighteen months previously. Three years later the disease was still present, though not advancing. In 34 cases observed by myself the average interval between infection and the first-recognized symptoms of tabes was nine and one-half years.

The factors of age and sex are of interest. The years between 25 and 45 show, by far, the largest number of cases. Tabes is rare in childhood.

The course of juvenile tabes is chronic and the prognosis is good as to life. The frequency of optic atrophy and blindness, however, should render one very guarded in the prognosis as to vision. Price and Shan-

non (Amer. Jour. Dis. of Children, Apr., 1912).

Infantile and juvenile tabes is the same as tabes of adults. Some of the symptoms, such as optic atrophy, are more common in the juvenile form; others, such as Romberg and ataxia, are more rare. Another difference is that the female sex decidedly preponderates. H. Barkan (Wiener klin. Woch., Mar. 13, 1913).

Case in a boy of 7½ years, with no luetic history in either parent, no symptoms of hereditary syphilis, who had begun to have gastric crises when 10 months old; they now occur every three months; the marked ataxic gait, muscular weakness, knee and Achilles jerks are absent. The blood exhibited a positive Wassermann and spinal fluid the same; no lymphocytosis, no globulin excess. C. Riggs (Med. Record, July 19, 1913).

Males are more liable to the disease than females in the ratio approximately of 10 to 1. Climate and race are unimportant factors, though, in my personal observations, out of 34 cases, 14 were Irish or Irish-Americans. Exemption in the negro is largely apparent rather than real, the disease probably occurring much oftener in the negro than hitherto supposed, but escaping recognition because of the anomalous clinical form—amaurotic tabes—in which it appears in this race. McConnell has published the records of 5 cases of tabes in pure-blooded negroes—the only cases observed in negroes in eight years' service at the Philadelphia Polyclinic,—all of whom exhibited the amaurotic type.

PATHOLOGY.—Ordinarily the gross macroscopic appearances are both conspicuous and constant. The cord is flattened anteroposteriorly from shrinkage in the posterior columns, which are also unnaturally

gray in color. Microscopically the nerve-tissue proper is found sparse or almost lost in certain localities, its place having been taken by an overgrowth of connective tissue. The area most affected is that of the lumbar enlargement and lower dorsal region, and the most damaged fibers are those of the columns of Goll and Burdach and the Spitzka-Lissauer tract. Higher up, and as the disease advances, similar changes are noted in Clarke's vesicular tract. Gowers's sensory tract in the anterolateral field is quite often involved and sometimes quite early. Less constantly the direct cerebellar tract shows similar changes; implication of the crossed pyramidal fibers or Turck's columns occurs only as a complication.

The posterior roots and ganglia are also involved, sometimes quite extensively. If the disease has reached the paralytic stage, the anterior gray horns are apt to show degenerative changes in both fibers and cells.

Destruction of nerve-elements in the posterior horns is often seen microscopically. From time to time an extensive degenerative disease of the peripheral nerve-fibers or neuraxons has been noted.

In tabes and general paresis, the ferment activity of the blood-serum is increased above normal through the presence of an excess of proteolytic ferments. F. H. Falls (Jour. Amer. Med. Assoc., Jan. 1, 1916).

The exact pathogenesis of tabes is as yet incompletely worked out, but enough has been proved to demonstrate that it is *not* a primary sclerosis of the posterior columns. The recognition and acceptance of the theory of the neuron were important steps in establishing this fact.

According to the newer teaching, the disease is a *centripetal parenchymatous atrophy or degeneration of sensory neurons followed secondarily by sclerosis, due to nutritional disturbances, which, according to Marie, affect first the ganglia on the posterior roots.*

These ganglia are the trophic centers for the sensory nerves and for the neuraxons, or axis-cylinder processes, of the dorsal columns of the cord. The neuron of the posterior spinal ganglia is a flask-shaped body, having an axis-process, or neuraxon, which divides into two branches, one passing to the periphery, forming an arborized or brush-like network of distribution in the skin or muscle-spindles. The other branch passes, with the posterior root, into the cord, dividing there into two branches, one of which ascends, while the other descends, in the posterior column. From both of these branches smaller fibers are given off which terminate in the posterior-horn gray matter. Some of these smaller fibers are short, others quite long. Marie divides them into three sets:—

(1) Short fibers which pass directly into the posterior horns after entering the cord.

(2) Fibers of medium length which run upward in the cord, some of them ending in the middle posterior horn, others passing into Clarke's column. These fibers are contained in the *fasciculus cuneatus* of Burdach.

(3) Long fibers coming chiefly from the roots of the cauda equina, passing thence the full length of the cord to the medulla and forming the *fasciculus gracilis* of Goll.

Marie's theory is as follows: "The changes found in the tabetic spinal cord are not the result of a primary

systemic myelopathy; they are the expression of a progressive degeneration of the posterior-root fibers; these spinal cord changes in tabes occur in segments, while each diseased posterior root furnishes a new contingent of degenerated fibers to the spinal cord." The initial cord-lesion is found in the dorsal-root zone and the Spitzka-Lissauer tract, due, Marie believes, to degeneration through the medium of the short (1) fibers. The degeneration in the columns of Burdach and Clarke's column, which is usually proportionate in degree to the duration of the disease, occurs through the medium of the fibers of the second group. The sclerosis observed in the columns of Goll he attributes to the degeneration of the long fibers of Group 3. Primary disease of the ganglia of the dorsal roots affords the explanation for the peripheral neuritis, which is parenchymatous and not interstitial, and is the result of disease of the trophic center of the peripheral nerve in the posterior ganglia. Marie, while maintaining this view, most strenuously admits that no evidence whatever of disease of the spinal ganglia is found in some cases, but it is quite possible to assume that very subtle and slight trophic changes at this point, although unrecognizable, are sufficient to produce the changes in the distal arborizations of the sensory neuraxons in the muscle-plates and skin and in the cord which are farthest removed from their nutritional centers, which changes give rise to the lightning pains, the diminished knee-jerks, pupillary changes, the vesical and sexual symptoms, and other sensory and trophic disturbances which mark the incipient stages.

The studies of Déjerine, Wallenberg, Rousoni, Blocq, Trepinski, Obersteiner, and Redlich, and the observations of Sherrington, Batten, and others, as to the relations in health and disease of the distal nerve arborizations to the muscular sense and its perversions, are all distinctively corroborative of this theory.

In a case of severe tabes with unusual motor paralysis and muscular atrophy, autopsy showed an almost universal degeneration of the anterior horns and of many of the cranial nerve-nuclei, suggesting that this is the primary seat of the lesions. The point of least resistance is in the sensory roots, but under conditions at present obscure the motor neurons may fall victims to the toxin, as in the present case, almost *pari passu* with the sensory. Occasionally the atrophy resembles progressive muscular atrophy; in this case the only distinguishing features lay in that the cell changes were rather more acute and that the affection of the cranial nerves was unusually widely spread. Tooth and Howell (Proceed. Royal Soc. of Med., Feb., 1912).

In amyotrophic tabes, a form with a comparatively rapid and progressive atrophy of the muscles due to disease of the anterior roots, the picture resembles that of polyn neuritis rather than tabes. Drey and Malespine (Lyon méd., Nov. 9, 1913).

The relationship of syphilis etiologically occurs, according to the views of Obersteiner and Redlich, through the presence of thickening of the pia, from old leptomeningitis presumably, which, by compressing the dorsal-root fibers at a point of lessened resistance, leads to their degeneration. Edinger's theory of a local invitation to a selective action of the poison, from functional fatigue, has also received the support of a certain number of observers.

COMPLICATIONS.—Locomotor ataxia often coexists with general paresis. Either of these may appear as the primary disease. Hemiplegia is also not very uncommon. Through extension of disease other areas of the cord may be involved, and symptoms of lateral sclerosis, progressive muscular atrophy, etc., added. Phthisis, heart disease, and nephritis are occasionally found coexistent, though not in any essential relationship.

Exophthalmic goiter, diabetes, and coma have also been observed.

PROGNOSIS.—The disease has been heretofore considered essentially chronic and progressive and the prognosis as regards cure extremely unfavorable. The degree to which the newer discoveries will modify this is not yet fully determined. They can, at best, affect the prognosis favorably only when the disease is recognized and properly treated in its incipency. Well-established tabes will, in all probability, remain a progressive, practically incurable affection.

The duration of the disease is very variable, sometimes extending over twenty to thirty years. It rarely causes death *per se*, a fatal ending occurring usually through the medium of some intercurrent affection, such as cystitis, pyelitis, trophic disorders, hypostatic pneumonia or bronchitis, or a profound asthenia.

Much symptomatic relief may be promised from intelligent treatment; in some cases long periods of arrest are obtained. Co-ordination can be materially improved and the pains and crises relieved. Spontaneous remissions in the disease have been often noted, but such results are much more positively assured from treatment. Usually the pains tend to

become progressively less as the disease advances, due to progressive diminution in sensory function.

Less easy of explanation is the sometimes marked improvement in the ataxic and painful symptoms which attends the onset of blindness. The enforced rest affords a partial explanation. Vicarious function is another possibility. Development of severe trophic symptoms is an omen of evil. Pseudoparalytic or actual paralytic helplessness may develop in the late stages and superinduce a fatal asthenia. Cases with well-marked and frequently recurring crises, especially gastric, cardiac, and respiratory, are said to run a shorter average course. The etiological element in individual cases does not appreciably modify the prognosis. Freedom from want and worry, on the other hand, are materially advantageous to the victim. In my personal experience the disease has run a far more rapid course in women than in men.

TREATMENT.—There is no specific known to be effective in tabes, even in cases positively due to syphilis as shown by the spirocheta. **Iodide of potassium** and **mercury** alone or in combination have proved equally inefficient, though, occasionally, in acute cases especially, an arrest of progress has been attributed, and probably correctly, to these agents. In cases in which, by intuition or good fortune, tabes has been recognized in its very incipency, the prompt and proper administration of either of these drugs might prove positively curative. The uncertainty of diagnosis would, however, render conclusions as to curative value at least a problem.

There is little, if any, clinical evidence to confirm the claims of the curative merits of the **salts of silver** and **gold**, of **ergot**, of **arsenic**, or of the other vaunted specifics in the older literature. A most positive exception is found, however, in the decided benefit at times resulting from **sodium cacodylate**. This drug should be given by mouth and not hypodermically.

The method of suspension, while effective in exceptional instances in modifying, at least, temporarily, certain obtrusive symptoms, has not survived the test of time, and, indeed, is often positively harmful.

Organotherapy in this disease was equally inglorious when first introduced. Ignorance as to the principles involved, crude and imperfect pharmaceutical methods and a considerable element of charlatanism were responsible for this disrepute. Evidence is now accumulating tending to show the adjuvant value of organotherapy.

The writer tried **adrenalin** in 5 cases of tabetic crises. In 3 of these the crises were gastric, in 1 rectal, and in the fifth laryngeal, with a gastric complication. The dose in the gastric crises consisted of from 4 to 6 drops of a 1 in 1000 adrenalin solution in 20 c.c. (5 drams) of water, which was administered per os. In the rectal crisis, after a previous irrigation of the rectum, from 3 to 5 drops in 20 to 40 c.c. (5 to 10 drams) of water were administered per rectum. These doses were given three times a day. The writer thus obtained the disappearance of pain, nausea, and vomiting in 4 of his 5 cases. This action set in after fifteen to thirty minutes, and continued for several hours. Upon giving adrenalin three times a day the attack ceased entirely. Roehmer (*Semaine méd.*, No. 2, p. 20, 1909).

The writer used, with favorable results, a combination of **organic products**. To prepare the extract, pituitaries, thyroids, parathyroids, and ovaries of intact sheep of unquestionable health, 4 years old, and testicles from perfectly sound cocks 1½ years old, are used. The glands are taken out under the strictest aseptic precautions, all fibrous tissue being removed as far as possible, and only the parenchymatous substance being used. The proportions of each organ thus treated are: **pituitary body**, 1 part; **thyroid** (including parathyroid), 2 parts; **ovary**, 10 parts; **testis**, 10 parts. This aggregate is reduced to a fine paste, placed in equal weight of chemically pure glycerin, allowed to macerate forty-eight hours, and then filtered.

The extract was administered by the intramuscular method, using an all-glass syringe with a half-inch needle of the finest bore. The favorite site of injection is the gluteal region, into which the needle is plunged for its full length. In sensitive persons the part is frozen with ethyl chloride before injecting. A hot compress is applied after the injection. In chronic conditions injections were originally made every second day for one week, then twice a week, etc.; the writer now gives a dose daily, with better results. F. R. Starkey (Prescriber, Apr., 1913).

Two indications are paramount: the retardation in progress of the disease and the palliation or control of symptoms. Three measures stand out conspicuously as having a certain though limited value, viz., **rest**, **electricity**, and the Fränkel method of "re-education." Conjointly and intelligently employed, the results are positive. The degree of rest necessarily varies. In the incipient stage pain and other sensory symptoms should be the guide. Five or six weeks of absolute rest in bed is ordinarily sufficient. The return to active

exercise should always be tentative and gradual, and for months, or even years, the amount of voluntary exercise should be guarded.

Compensatory exercises aim to correct 4 main abnormalities in walking. These are: (1) **Hyperextension** at the knees. It may be inadvisable to try to correct it at first. Later the patient practises slowly the movement of sinking and rising at the knees, watching himself carefully and avoiding all jerks. Standing may also be practised with the knees in a partially flexed position. (2) **Overaction** of the swinging leg with dorsal flexion of the foot. Here the patient practises walking with the leg sharply flexed at the knee, touching the floor first with the toe and then coming down gradually on the whole foot. This is to be done slowly, aiming at steadiness. At the beginning of the movement the foot often leaves the floor with a little twist, and this is to be combated. Usually the foot is best held pointing directly forward. (3) **Lack of plantar flexion** of the foot of the supporting leg to throw the body weight forward. Patient practises throwing the body weight forward by means of careful attention to the movements of the supporting foot. These first three defects are corrected by training the eyes to watch the various movements; for the fourth, the equilibrium sense has to be trained. (4) **Faulty position** of the hips with a corresponding faulty position of the trunk. Correct position may be favored at first by the physician's pushing in against the trochanters of the patient as he walks. The tendency to bend forward is corrected by keeping the buttocks forward, and this may be aided by slight pushes or taps. The development of the equilibrium sense may be aided by having the patient notice that his tendency to topple over can be overcome in a measure by quickly pushing out his pelvis along the line in which he feels himself falling. These exercises may be

practised with the aid of the support of another person, then with sticks, then without sticks, and finally with closed eyes.

In far-advanced cases the patient cannot stand, and must be trained to. The exercises are along similar lines, the patient being supported. They should be practised for short periods with frequent intervals of rest. The treatment must be continued six months to a year. It is not suitable for all cases, the more common contraindications being optic atrophy, a heart lesion, poor general physical condition, and frequent pains or crises. H. M. Swift (N. Y. Med. Jour., from Boston Med. and Surg. Jour., Jan. 21, 1915).

Any physician can train tabetics, and the **mechanical aids** can be improvised or dispensed with entirely in the mild cases. As the tabetic does not feel fatigue readily, he must be watched to stop short of fatigue, as this would weaken the muscles. The **exercises** benefit even in the severest cases, as a rule, and decided improvement can be counted on in 50 per cent. of all cases. The exercises can be done in bed or on the sofa at first. Five to fifteen minutes are usually long enough for the sitting, but it should be repeated two or three times a day. It may be necessary to support the limb at first or suspend it in a sling.

A straight, zigzag or spiral chalk-mark on the floor to follow, or a book or cigar-box to step over may prove useful exercises. The aim should be to train the patient in the movements needed in daily life: walking, climbing stairs, knocking, writing and buttoning garments. A late feature is inability to extend the leg at the knee. The knees thus give way when the tabetic tries to stand up. The patient strives to compensate this by innervation of the extensors of the knee, and this generally results in an overcorrection. The knee is extended too far and held in this overextension. The same occurs in the hip-joint, shoulder, and elbow.

By thus analyzing the elements of the movements, the patient can be shown and taught how to correct errors by voluntary innervation and utilization of the remnants of sensibility. Jacobsohn (Therap. der Gegenwart, Oct., 1915).

Any evidence of an aggravation is a danger-signal, demanding a return to absolute rest. The writer does not agree with Church as to the harmful effect of rest upon the ataxia or any other symptom. Involuntary exercise by means of **massage** and certain mechanical appliances (Londer) may serve a useful purpose. In the ataxic stage the same rule should apply. I have seen the pains, ataxia, sphincteric disturbances, and various crises either greatly lessen in severity or entirely disappear from prolonged absolute rest.

Massage in combination with **mechanical treatment** acts as a sedative to spasm and a tonic in the presence of paresis. At first gentle, passive movements and effleurage should alone be employed, in order merely to diminish contractures and relieve pain by displacing the blood from the parts. Later, the massage should be carried out so as to improve the condition of the paretic muscles; re-education is also indicated in this second period. Michaud (Lyon méd., June 23, 1912).

Next in order to rest is galvanism. Of the value of **static electricity** I have no personal knowledge. Faradism in my experience is often harmful. **Galvanism** should be employed daily. The current should not exceed at first 5 milliampères. The *séances* should at first be limited to ten or twenty minutes, gradually lengthened to one or even two hours, daily. The electrodes (Erb) should be applied to the spine, thoroughly wet, of course; one over the upper dorsal

region, the other over the upper sacral spine. The selection of the pole is immaterial. Occasionally it is of advantage, if the pains are severe or the ataxia extreme, to apply the electrodes one under the sole of each foot, the current making the direct circuit of the nerves chiefly affected. The benefit derived by some patients from galvanism is quite decided. I do not believe any appreciable effect is exerted upon the intraspinal lesion, but that the radiculitis and associated neuritic condition are at times modified favorably. The well-known susceptibility of tabetics to psychic appeal may be a factor to some degree.

When pains are very severe, hot sitz-baths, the cold pack, ice-coils to the leg or an ice-bag or the cautery to the spine, may be tried with or without anodynes, in particular antipyrin, acetanilid, acetphenetidin, aspirin, or codeine. Morphine should be employed as a last resort and given hypodermically. Thiosinamine sometimes relieves pain in daily doses of 0.06 to 0.10 Gm. (gr. j-iss).

After trying many substances applied by spinal injection, the writers found solution of magnesium sulphate efficacious in controlling tabetic pain. Such injections produce a true "leucocytic shower" and a sort of therapeutic meningitis which favors the resorption of meningitic products and cessation of pain. Roger and Baumel (*Presse méd.*, Aug. 7, 1912).

To relieve tabetic pains the writer recommends the following:—

℞ *Thiosinamine*,

Glycerināā 1 Gm. (15 gr.).

Sodium salicylate . 2 Gm. (30 gr.).

Sterile dist. water.. 10 c.c. (2½ dr.).

M. Sig.: One cubic centimeter to be injected intramuscularly daily or on alternate days.

Mueller (*Riforma Medica*; *Med. Record*, May 15, 1915).

Intramuscular injection of 0.5 c.c. (8 minims) of 1:1000 adrenalin solution was found to cause a paradoxical drop of 30 to 40 mm. Hg. in the blood-pressure in cases of tabetic gastric crisis. Complete relief from the pain was simultaneously experienced. The pressure rose again and the pain returned in from half an hour to fifty minutes. A similar paradoxical lowering of pressure had already been observed in dementia precox, and by Newberger in cerebral syphilis and menstruation. Bayard Holmes (*Lancet-Clinic*, Oct. 30, 1915).

In recent years, efforts have been made to control the crises of tabes by blocking the nerve-roots, by dividing the latter in the spinal canal, an operation known as rhizotomy. The actual value of this is still *sub judice*.

The benefits of rhizotomy may be attained without an operation, by blocking the nerve-roots involved. The writer injected 100 c.c. of the fluid in the back, between the sixth and tenth ribs, at the emerging point of the nerves, forcing the fluid deep into the muscle on each side. He introduced the long needle close to the costovertebral articulation until it hit the rib; then it was drawn back a little, pointed upward to the upper margin of the rib and 5 c.c. of the fluid expelled at each point. The method differs from the epidural injection technique; it anesthetizes the nerve-trunks for over six hours. It can be applied repeatedly. The same technique might prove effectual for tabetic pains elsewhere, lancinating pains in the arm or leg. There is sometimes a local pain at the point of the injection, about two hours later, which he occasionally combats by subcutaneous injection of a small amount of some sedative. The patient was a man of 44 who had gastric crises every month and finally every week for days at a time. The attack was arrested at once by deep anesthetic injection; 100 c.c. were injected at this time and three other attacks within

the following week were likewise aborted, but not quite so successfully, the amounts used ranging only from 65 to 80 c.c. The crises recurred after a month, but the patient had left town. König (Jour. Amer. Med. Assoc., from Med. Klinik, Sept. 24, 1911).

The writer tried **rhizotomy** for gastric crises in a case of tabes in a man of 43. The patient was at once relieved. After five months they recurred in a brief and mild form, once or twice a week, but disappeared again during the seventh month. In the majority of the 28 cases published to date there has been recurrence later of the crises in a mild form, but the operation has often been of life-saving importance. Zinn (Berl. klin. Woch., Sept. 11, 1911).

For gastric crises the writer resorted to **Förster's method of division** within the spinal canal of the **sensory roots** of the tenth, eleventh, and twelfth dorsal spinal nerves. For four weeks after the operation the patient was free of trouble. Then the vomiting returned, but without the girdle sensation and without the pain. He concluded that the vomiting was the result of the gastric movements controlled by the vagi; in some cases at least the primary cause is involvement of the vagus or its center; the pain is secondary to the vomiting. Exner (Deut. Zeitsch. f. Chir., ci, 576, 1911).

In gastric crises the writers tried **Franke's operation**, which they consider superior to that of Förster, with satisfactory results. They prefer a single vertical incision which divides the muscular fibers in the direction they run and renders easy the exposure of the intercostal nerves. The ventral position is good if the lumbar region is raised by means of a sand cushion under the abdomen. Four months after operation the 2 patients suffer no pain, have excellent digestion, have gained in weight. L. Maire and G. Parturier (Presse méd., July 10, 1912).

The operation **rhizectomy**, generally called by the writer's name, has been done to relieve tabetic crises in 44 cases; the resection was not extensive enough in some, so that the pains recurred later; in some other cases crises developed in other nerve regions; 5 of the patients died, and no benefit was obtained in 3 cases. Another cause for failure may be that in certain cases the vagus is responsible for the crises. Förster (Wiener klin. Woch., June 20, 1912).

The writer reports his own experience in 1 case with Franke's technique, the **tearing out of the intercostal nerves**. In 17 published cases gastric crises were cured seven times; they recurred in 8 cases. In his own case the cure has been complete during the fifteen months to date. The patient was a woman of 64 who had had tabetic gastric crises during fifteen years. The fifth, sixth, seventh, eighth and ninth intercostal nerves were taken up in turn on a grooved sound and wound slowly on the sound until they tore; the peripheral stump was then cut. The fulgurating pains in arms and legs were not modified, but the gastric crises were abolished. Maclaure (Arch. gén. de chir., Nov. 25, 1913).

Sauvé and Tinel method seems to promise still better results, but it has only been worked out experimentally thus far. They propose the **ligation of the intercostal nerves** between the ganglion and the dura.

In the writer's case, a man of 53, the seventh, eighth, and ninth pairs of posterior roots were resected; while the tenth pair was being resected the pulse and respiration stopped suddenly, but heart action was resumed spontaneously in a few seconds and pressure on the thorax started respiration. This complication can be avoided by deadening the sensibility of each nerve just before it is cut. There was great improvement and cessation of the pains during the six weeks he was in the hospital. G. Patry (Rev. méd. de la Suisse rom., xxxv, 297, 1915).

For the relief of the various crises, symptomatic remedies are used. Full doses of **cerium oxalate** usually relieve vomiting. Heart-tonics, such as **caffeine**, **strychnine**, etc., may be indicated in vagus involvement. Cystitis may be treated symptomatically as an ordinary cystitis with relief. A simple device which almost invariably affords relief and may be magically effective in lessening nocturnal cystic irritability, especially in prostatic enlargement, is that of **elevating the foot of the bed** with two-inch blocks of wood. The exhausting effects of disturbed sleep are at times corrected absolutely by this procedure. Trophic lesions are occasionally quite intractable. **Strychnine** in doses of $\frac{1}{30}$ to $\frac{1}{16}$ grain (0.002 to 0.004 Gm.) will at times retard the progress of an optic atrophy. Strychnine should, however, be given always with caution in this disease.

The advanced tabetic case which is practically bedridden and has had all forms of antisiphilic treatment does better under **strychnine sulphate** than with symptomatic treatment. The writer's patients were treated at three-month periods with gradually increasing doses, beginning at $\frac{1}{30}$ grain (0.001 Gm.) 3 times a day, up to $\frac{1}{4}$ grain (0.015 Gm.) 3 times a day. The last month they were given $\frac{1}{4}$ grain continuously. (Osnato (Med. Rev. of Rev., Mar., 1918).

Case of a woman with tabetic symptoms in whom the Wassermann reaction became negative and the number of cells in the spinal fluid diminished, while gait and station were much improved. The treatment consisted of frequent **mercurial inunction**, together with as complete **evacuation of cerebrospinal fluid** as possible about once a week or two weeks. A number of cases of tabes, taboparesis, and paresis were treated in the same way, as a rule with distinct advan-

tage and without any untoward result. S. F. Gilpin (Phila. Neurol. Soc.; Med. Rec., Jan. 18, 1919).

The demonstration of the spirocheta in the nervous tissues has led to a revival in the use of **mercury**, together with **neosalvarsan**.

The cerebrospinal fluid circulates imperfectly and there is very little absorption of this fluid by the cortical or spinal cells. Hence, intraspinal medication is unsound. The writer obtained most satisfactory results from intravenous **arsphenamine** injections given on alternate days for three to four weeks according to the symptoms, followed by complete rest or weekly or semi-weekly injections of **mercuric salicylate** for four to six weeks, and then again starting in with the arsphenamine injections. Some patients received 40 or 50 intravenous injections within a year or eighteen months. B. Sachs (Arch. of Neurol. and Psych., Mar., 1919).

Intraspinal treatment of tabes with **arsphenamine** or **mercury** has of late come into widespread use. The Swift-Ellis method or **autoserum-salvarsanized serum** treatment constitutes one form of this type of procedure.

Reduction of intraspinal pressure by removal of cerebrospinal fluid increases the permeability of the ependyma. Applying this fact, the author was able to demonstrate appreciable amounts of arsenic in the spinal fluid twenty-four hours after intravenous injection of an organic arsenical in 25 out of 26 cases. He gives an injection of **salvarsan**, **neosalvarsan**, or **arsenobenzol** and taps the spinal canal within twenty minutes after the injection, withdrawing fluid until it comes only drop by drop. Barbat (Jour. Amer. Med. Assoc., Jan. 19, 1918).

Sixteen cases of tabes and cerebrospinal syphilis, with symptoms referable mainly to the urinary tract, were subjected to **intraspinal treatment** with **mercurialized serum**, with re-

sults better than those usually following other methods. The treatments generally consisted in intraspinal injection of 0.001 Gm. ($\frac{1}{100}$ grain) of **mercuric chloride** in normal horse serum, diluted with normal salt solution to 30 c.c. (1 ounce). The injections were given about once weekly for 4 doses, followed by a rest of four to eight weeks. The reactions were never more than moderately intense. The spinal Wassermann reaction was changed from positive to negative in 7 cases, and the degree of fixation greatly reduced in 6 others. Marked urinary incontinence was cured in one case, greatly improved in another, and not affected in a third. Slight incontinence was cured in 3 and much relieved in 4. Increased frequency was cured or much diminished in 8 cases, dribbling after voiding cured in 4 and improved in 6, and sexual powers improved in 6 and restored to normal in 2. All patients having pains in the back and legs were relieved, and the residual urine was greatly reduced. Watson (Jour. Am. Med. Assoc., Feb. 2, 1918).

Injections of **mercuric chloride intraspinally** practised in tabes. From $\frac{1}{100}$ to $\frac{1}{10}$ grain (0.001 to 0.0015 Gm.), dissolved in 1 to 2 c.c. (16 to 32 minims) of distilled water, was introduced into $\frac{1}{2}$ ounce (15 c.c.) or more of spinal fluid collected in a glass funnel. Not until the writer combined the intraspinal and intravenous methods of treatment did both the blood and spinal fluid become negative to all tests. The treatment removed the clinical symptoms for at least a considerable period. R. B. McBride (South. Med. Jour., June, 1918).

After five years' experience with the Swift-Ellis and Ogilvie techniques, the writers take issue with a recent critic of the results of **intraspinal treatment** of cerebrospinal syphilis. The method is most valuable and not dangerous if properly carried out. The intravenous method often gives as good results as can be expected from any form of treatment, but in some cases it falls very far

short of such results, and in these the resort to intraspinal treatment is usually followed by good recovery. The need for intraspinal therapy is especially marked in those who cannot endure intensive treatment with mercury or with arsphenamine intravenously. Cummer and Dexter (Jour. Amer. Med. Assoc., Sept. 7, 1918).

The writer's best results were obtained by the addition of **arsphenamine** in small quantities directly to the cerebrospinal fluid. In paretics a prolonged remission is the best that can be accomplished. In tabes, he has seen cases in which, clinically, progression had been retarded for three years. The best effects follow combined general and intraspinal treatment. Tredway (Penn. Med. Soc.; N. Y. Med. Jour., Mar. 8, 1919).

No final proof of the curative value of the Swift-Ellis or other intraspinal methods is however, in evidence (See also the article on DIOXY-DIAMIDO-ARSENOBENZOL, Vol. II).

Swift and Ellis Method.—The blood-serum of recently treated or cured syphilitic has a marked trophic action on the specific spirochete and the following technique has been devised by Swift and Ellis for bringing an effective medicinal agent into immediate contact with the diseased process without incurring the danger of direct injection of salvarsan into the subarachnoid space. A dose, generally the maximum of salvarsan or neosalvarsan, is given intravenously in the usual manner. At the end of an hour from 50 to 60 c.c. (1.7 to 2 ounces) of the patient's blood are drawn by means of venous puncture, clear serum is separated, diluted to 40 per cent. with normal salt solution heated to 132.8° F. for half an hour, kept cool until the following day, then warmed to body temperature and injected into the subarachnoid space by means of lumbar puncture after the withdrawal of about 15 c.c. ($\frac{1}{2}$ ounce) of spinal fluid, the amount of diluted serum injected be-

ing 30 c.c. (1 ounce). After the first few injections, if well tolerated, 40 c.c. (1½ ounces) of a 50 per cent. serum is usually injected. It must be injected slowly without much pressure. After the injection the patient is kept in bed for a day with head covered. The general rule is to give eight or ten treatments, one every second week and then discontinue them for a time, repeating, if necessary, and using as indices the Wassermann test with the blood and spinal fluid and the cell and protein estimations of the latter. The method is the most promising one for tabes and paresis that has yet been devised. W. H. Hough (Jour. Amer. Med. Assoc., Jan. 17, 1914).

In 5 cases of tabes and 3 of cerebrospinal syphilis in which a modification of the Swift and Ellis method of treatment was applied, **salvarsan**, 0.6 Gm. (10 grains), was first given intravenously, 75 to 100 c.c. (2½ to 3½ ounces) of blood withdrawn an hour later, serum from this blood soon after heated in a water bath at 56° C. for half an hour, and an intraspinal injection of 25 to 35 c.c. (¾ to 1¼ ounces) of the undiluted serum given at once, spinal fluid not exceeding 35 c.c. (1¼ ounces) in amount having previously been allowed to drain off. After the injection all pillows were taken away, the foot of the bed was elevated, and the patient kept on his back for at least an hour. Treatments were repeated at seven- to twenty-day intervals. The patients were all relieved from pain and showed definite improvement in locomotion, in some almost to normal. The psychic effect was also marked, and the nutrition rapidly improved. T. R. Boggs and R. R. Snowden (Arch. of Internal Med., June, 1914).

WILLIAM B. PRITCHARD,
New York.

TACHYCARDIA. See HEART:
FREQUENT PULSE.

TALIPES. See ORTHOPEDIC SUR-
GERY.

TAMARIND.—*Tamarindus*, N. F., is the acidulous pulp of the fruit of a semitropical and tropical tree, the *Tamarindus indica* (fam., Leguminosæ). Before tamarinds enter commerce, the shell of the fruit is removed, and the inner portion is, in India, molded into a mass, to which sometimes sugar is added. In Egypt it is formed into cakes and dried in the sun, and in the West Indies hot syrup is poured over the pulpy mass. Tamarinds, in the shops, form a dark-brown soft mass, having a fruity odor and a subacid to strongly acid and sweet taste. Tamarinds contain a very little malic acid, 4 to 6 per cent. of citric acid, 5.3 to 8.8 per cent. of tartaric acid, 4.7 to 6 per cent. of potassium bitartrate, 12 to 20 per cent. insoluble matter, and about 13.9 per cent. of seeds. A trace of acetic acid, supposed to result from sugar-decomposition, and a little tannin in the seed coats, complete the constituents. Tamarind is an ingredient (10 per cent.) of confectio sennæ, N. F., in which it is combined with senna (10), cassia fistula (16), prunes (7), figs (12), sugar (55.5), oil of coriander (0.5), and water.

ACTION AND USES.—Tamarind is a mild laxative and refrigerant, due to the combination of its acids and acid salts. It may be given in doses as large as 1 ounce (30 Gm.) with safety; larger doses may give rise to griping. An infusion, strained and allowed to cool, makes a grateful draught in **fevers**, when the stomach is in good condition. Like nearly all similar vegetable preparations, it is moderately diuretic. A tamarind whey, made by infusing an ounce (30 Gm.) of the pulp in a little boiling water, and adding this to a quart of milk, may be used as a refrigerant in **fevers**.

TANNIC ACID.—*Acidum tannicum*, U. S. P., specifically known as gallotannic acid, is an organic acid obtained from nutgall (*Galla*, U. S. P.), which is an excrescence found on *Quercus lusitanica*, or dyers' oak (fam., Cupuliferæ), caused by the punctures and deposited ova of the gall-wasp, or *Cynips gallæ tinctoria*.

(order, Hymenoptera). It is also found in chestnut wood and bark, in pomegranate bark, and in sumach. Tannic acid occurs as yellowish-white or greenish crusts or powder, without odor or having a faint, characteristic odor, and a strongly astringent taste. It is very soluble in water, alcohol, and in glycerin.

Tannic acid is incompatible with alkalis, lime solution, alkaloids, albumin, gelatin, starch, salts of antimony, copper, iron, lead, mercury; compounds of iodine, bromine, chlorine, nitrites (including spirit of nitrous ether), permanganates, chlorates, and other oxidizing agents; forming insoluble compounds with alkaloids, it has been used as an antidote in poisoning by alkaloids, as well as by the metallic incompatibles named.

PREPARATIONS AND DOSES.

—The official preparations of tannic acid are:—

Acidum tannicum, U. S. P. (tannic acid or tannin). Dose, 3 to 10 grains (0.2 to 0.6 Gm.).

Collodium stypticum, N. F. (flexible collodion containing 20 per cent. tannic acid).

Glyceritum acidi tannici, U. S. P. (glycerite of tannic acid, containing 20 per cent., by weight, tannic acid). Dose, 15 minims (1 c.c.).

Trochisci acidi tannici, U. S. P. (troches containing 1 grain—0.06 Gm.—tannic acid). Dose, 1 or 2, three or four times daily.

Unguentum acidi tannici, U. S. P. (ointment containing 20 per cent. tannic acid).

The principal unofficial compounds of tannic acid are:—

Tannalbin (tannin albuminate exsiccated, containing 50 per cent. tannin). Dose, 15 to 60 grains (1 to 4

Gm.) in tablet or in powder, with water.

Tannigen (diacetyl-tannin). Dose, 3 to 10 grains (0.2 to 0.6 Gm.).

Tannismuth (bismuth bitannate). Dose, 5 to 10 grains (0.3 to 0.6 Gm.).

Tannoform (tannin-formaldehyde). Used externally.

Tannopine (hexamethylenamine-tannin). Dose, 15 grains (1 Gm.); children, 3 to 8 grains (0.2 to 0.5 Gm.).

Glyceritum iodo-tannin carbolizatum (Sajous). (Carbolized glycerite of iodo-tannin contains iodine, 2 Gm.; tannic acid, 15 Gm.; water, 250 c.c.; mix, filter, and evaporate to 60 c.c., and add glycerin, 120 c.c.; carbolic acid, liquid, 2 drops).

PHYSIOLOGICAL ACTION.—

When tannic acid is applied locally to the skin or mucous membranes it constricts the blood-vessels and temporarily diminishes the vascularity of the parts; its affinity for albumin intensifies its astringent effect. Taken internally it lessens secretions and produces constipation. By uniting with albumin in the stomach it is transformed into tannalbin or tannin albuminate; this latter is then slowly decomposed by the alkaline contents of the intestines into gallic acid, and as such is absorbed. The researches of Rost have shown that tannic acid given by the mouth, subcutaneously, or otherwise, appears as gallic acid in the urine, along with other decomposition products of tannin; when given by the mouth it appears in the feces as gallic acid; tannic acid has, therefore, no remote astringent action on secretions, on blood-vessels, or on urinary excretion. Tannic acid is destroyed before it arrives at the lower part of the intestine. Tannic

acid only acts as such before it is absorbed.

THERAPEUTIC USES.—Tannic acid has been used locally in various forms of **hemorrhage—epistaxis, uterine hemorrhage, passive gastric and intestinal hemorrhage, hematemesis, hematuria, and in hemoptysis** (in spray). For its local astringent action it may be used in **relaxed mucous membranes, relaxed uvula, aphthous stomatitis, spongy gums, pytalism, and chronic pharyngitis**. In **tonsillitis and pharyngitis** the glycerite is a good topical application; the glycerite may also be used as a spray, properly diluted, in **hemoptysis**. The odor of **ozena** and other affections attended by **fetor** may be overcome by the application of absorbent cotton moistened in a saturated aqueous solution of tannin and then dried. In simple **chronic rhinitis and rhinopharyngitis**, the carbolyzed glycerite of iodo-tannin is a valuable application.

In the early stage of **cholera**, Cantani used large enemata of tannic acid up to and beyond the ileocecal valve. From $1\frac{1}{2}$ to 5 drams (6 to 20 Gm.) of tannic acid dissolved in 4 pints (2 liters) of warm water, with the addition of 30 drops of laudanum and $1\frac{1}{2}$ ounces (45 Gm.) of powdered gum arabic are injected at suitable intervals.

A suppository containing 2 to 5 grains (0.10 to 0.3 Gm.) of tannin has been successfully used in **prolapse of the rectum**, and in **bleeding hemorrhoids**. Tannin in solution is beneficial in **excoriations about the anus and scrotum**, and in **anal fissure**.

In **vaginal leucorrhea** a saturated solution of tannic acid on cotton makes a valuable application. The

glycerite is an excellent form for use in **cervical uterine catarrh**. In **uterine carcinoma** dressings of the glycerite will moderate the discharge and allay the odor, especially if combined with the glycerite of phenol.

In **gonorrhea**, after the acute stage is passed, tannic acid is effective. In women a watery solution may be used as a vaginal injection, or the vagina may be packed with tannin.

Tender nipples and tender feet may be hardened with a 1 per cent. solution of tannin. A lotion of tannic acid is often efficient in **herpes**. It is useful in **phagedenic ulcer** and **alopecia circumscripta**. The stinging pain and itching of **subacute eczema** is relieved by an application of the glycerite twice daily. The ointment, somewhat diluted, has proved beneficial in **pityriasis capitis (dandruff)**. **Impetigo and intertrigo** have yielded to the use of the ointment. Tannin is usually an ingredient in preparations used to relieve **hyperidrosis of the hands and feet**; in a 1 per cent. solution it has been recommended in **offensive axillary sweating**. In **burns** tannin subdues the pain and hastens the formation of granulations and healing. A solution (1 to 4) of tannin in tincture of benzoin is said to prevent the formation of pustules in **variola**.

In **chronic inflammations of the conjunctiva**, especially **pannus**, tannin has given good results.

A lotion of 2 parts tannin to 10 parts alcohol painted on the gums and around the teeth relieves almost every kind of **dental pain**; it is also the best application in **Riggs's disease (pyorrhea alveolaris)**, the loose teeth tighten under its use and become available for mastication.

To expel threadworms (*Oxyuris vermicularis*) a solution may be injected or suppositories used.

A 5 per cent. alcoholic solution of tannin is a very satisfactory disinfectant for the hands of the surgeon.

C. SUMNER WITHERSTONE,
Philadelphia.

TANSY.—*Tanacetum* (tansy, bitter-buttons, parsley or scented fern) is the dried leaves and tops of *Tanacetum vulgare* (fam., Compositæ). Tansy contains about 0.5 per cent. of volatile oil, resin, tannin, fat, sugar, gum, citric, tartaric, and malic acids and the amaroid tanacetin, which is yellowish white, granular, odorless, fusible, soluble in ether, less freely soluble in alcohol, and sparingly soluble in water.

PREPARATIONS AND DOSES.—*Tanacetum* (leaves and tops; unofficial). Dose, 20 to 60 grains (1.30 to 4 Gm.).

Oleum tanacetii (tansy oil; unofficial). Dose, 1 to 3 minims (0.05 to 0.2 c.c.).

PHYSIOLOGICAL ACTION.—Tansy is an aromatic, bitter tonic, and, by virtue of its volatile oil, it is diuretic and emmenagogue, and in poisonous doses is a violent irritant to the stomach and intestines. Many deaths have been reported from its use.

POISONING BY TANSY.—Large doses, 1/2 an ounce (15 c.c.) or more of the oil, taken to procure abortion, cause disturbance of the respiration, depression of the heart action, clonic spasms, and death. The usual symptoms, preceding death, are vomiting and purging, severe abdominal pain, a rapid, feeble pulse, slow respiration, dilated pupils, convulsions of an epileptiform type, coma, and asphyxia. Alarming symptoms have followed the use of from 15 to 30 minims (1 to 2 c.c.) of the oil of tansy. Sometimes it causes abortion.

TREATMENT OF POISONING.—Siphon out the stomach, refilling and emptying several times with abundance of water; give emetic of apomorphine hydrochloride hypodermically (2 to 5 minims—0.12 to 0.3 c.c.—of 2 per cent. solution). If throat is not severely inflamed, mus-

tard (4 drams—15 Gm.—in 1 to 4 ounces—30 to 125 c.c.—water) can be used, or zinc sulphate (20 grains—1.3 Gm.—in 1 ounce—30 c.c.—water), castor oil (1 ounce—30 c.c.) or magnesium sulphate may be used instead. Give demulcent drinks of flaxseed tea, barley-water, elm-bark mucilage, or arrowroot pap. Allay pain with 1/4 grain (0.015 Gm.) morphine, or 10 to 20 minims (0.6 to 1.3 c.c.) of laudanum.

THERAPEUTIC USES.—Oil of tansy was formerly used in functional dysmenorrhea, amenorrhea, and ovarian neuralgia in doses of 1/2 to 1 minim (0.03 to 0.06 c.c.), in pill or dropped on sugar. In conjunction with hot drinks and hot applications it is used in amenorrhea attributed to cold. It has some anthelmintic effects, but its use for this purpose is not advised. For domestic uses an infusion (tansy tea) is made by steeping 1 ounce (30 Gm.) of the leaves or tops in 1 pint (500 c.c.) of boiling water; of this 1 to 2 ounces (30 to 60 c.c.) may be taken. W.

TAPEWORM. See PARASITES, DISEASES DUE TO.

TAR.—*Pix liquida* (U. S. P.), pine tar, or tar, is an aromatic oleoresin obtained by the destructive distillation of the wood of *Pinus palustris* and of other species of *Pinus* (fam., Coniferae) of Europe and America, that coming from North Carolina and Sweden being the best. It occurs as a thick, blackish-brown, viscous mass having a peculiar odor; contains oil of turpentine, pyrocatechin, acetic acid, acetone, creosote, phenol, xylol, methylic acid, etc., and is blackened by wood-smoke. It is soluble in less than its own bulk of alcohol, ether, or chloroform, and is slightly soluble in the volatile and fixed oils.

Upon redistillation tar yields pyroligneous acid (crude acetic acid) and an empyreumatic oil called oil of tar, which is official. Oil of tar, when fresh, is almost colorless, but with age becomes oxidized and dark reddish-brown in color; it is a volatile fluid, of acid reaction, has the odor and taste of tar, and is soluble in alcohol. The residue, after the distillation, is pitch (*pix solida*)—unofficial—a black solid which has a shining surface

on fracture, melts in boiling water, and consists of resin and various empyreumatic resinous products which are collectively called pyretin. *Pix solida* is chiefly used in the preparation of plasters, and is entirely different from the residue of coal-tar, or "gas-pitch."

Burgundy pitch, recognized in the British Pharmacopeia as *Pix burgundica*, is pitch derived from the Norway spruce (*Abies excelsa*). It softens and fuses at the temperature of the body. *Canada pitch* (*Pix canadensis*) is derived from the hemlock spruce of the United States and Canada. Both these forms of pitch are used as plasters.

Coal-tar, produced by the distillation of coal, varies in composition, and contains, in addition to about 0.1 per cent. of phenol, such bodies as sulphur, ammoniacal compounds, aniline, pyridine, quinones, etc.

Lyxol and *pixol*, derivatives of tar, will be considered in separate sections at the close of this article.

PREPARATIONS AND DOSE.—*Pix liquida*, U. S. P. (tar; pine-tar). Dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Oleum picis liquidæ rectificatum, U. S. P. (rectified tar oil). Dose, 3 minims (0.2 c.c.).

Syrupus picis liquidæ, U. S. P. (syrup of tar), consisting of tar, 5 parts; magnesium carbonate, 10 parts; alcohol, 50 parts; sugar, 850 parts, and water, enough to make 1000 parts. Dose, 1 fluidram (4 c.c.) or more.

Unguentum picis liquidæ, U. S. P. (tar ointment), consisting of 10 parts of tar mixed with 3 parts of yellow wax and 7 parts of lard.

The following tar preparations are recognized in the N. F. for internal use:—

Elixir picis compositum, N. F. III (compound elixir of tar), each fluidram (4 c.c.) of which contains $\frac{1}{50}$ grain of morphine sulphate, together with wine of tar, syrup of wild cherry, and syrup of Tolu. Dose, 1 fluidram (4 c.c.).

Glyceritum picis liquidæ, N. F. (glycerite of tar), each fluidram (4 c.c.) of which contains about 4 grains (0.25 Gm.) of tar. Dose, 1 fluidram (4 c.c.).

Mistura olei picis, N. F. (tar mixture), each 2 fluidrams (8 c.c.) of which con-

tains about 4 minims (0.25 c.c.) of oil of tar, masked with licorice, peppermint, chloroform, and sugar. Dose, 2 fluidrams (8 c.c.).

Vinum picis, N. F. (wine of tar), each 2 fluidrams of which contains about 5 grains (0.3 Gm.) of tar. Dose, 2 fluidrams (8 c.c.).

For external use:—

Liquor picis alkalinus, N. F. (alkaline solution of tar, "liquor carbonis detergens"), consisting of tar, 2 parts; potassium hydroxide, 1 part, and water, 5 parts

Unguentum picis compositum, N. F. (compound tar ointment), containing oil of tar, 4 parts, and zinc oxide and tincture of benzoin, 2 parts each, in every 100 parts of the ointment base.

Tar-water, unofficial, is prepared by shaking 1 part of tar with 4 parts of water several times in one day, then decanting and filtering. Dose, 1 to 2 pints (500 to 1000 c.c.).

Liquor carbonis detergens, essentially a solution of *coal-tar* in tincture of quillaja (soap bark), is at times assimilated with *Liquor picis alkalinus*, N. F., but is preferably made, according to Stelwagon, as follows: Coal-tar, 4 parts; strong soap-bark tincture, 9 parts; digest for eight days, frequently shaking and stirring, and finally filtering. The soap-bark tincture is made with 1 pound of soap bark to 1 gallon of 95 per cent. alcohol, allowed to digest for a week or so.

PHYSIOLOGICAL ACTION.—Locally, tar is slightly irritating to the skin. It acts strongly as an antiseptic in skin diseases, and is also a valuable disinfectant. It is absorbed rather readily from the skin, and may thus cause darkening of the urine, as if phenol had been used. It has been credited with expectorant properties.

Coal-tar has the property of softening keratin. Its antiseptic action is greater than that of phenol, and it has more penetrating power. It is much less active locally than the wood-tars, but is advantageous in that its odor, after local application, soon passes off.

POISONING BY TAR.—If in prolonged contact locally, tar may produce a papular, erythematous, rubeoloid, urticarial, or acneiform eruption; the last has

been called *acne picealis* (tar acne) by Hebra. Where a considerable area has been exposed to its action, tar, through absorption, may give rise to toxic symptoms similar to those of poisoning by phenol: fever, foul tongue, eructations, vomiting and diarrhea, epigastric pain, tarry evacuations, and a severe headache or sensation of heaviness or oppression; strangury and ischuria, with darkish urine turning almost black in color and emitting, like the stools, the odor of tar. When taken internally, tar may give rise to erythema, vesicles, or papules, accompanied by severe itching. Long-continued or large doses of tar give rise to anorexia and indigestion, depress the heart's action, and cause nervous exhaustion. A fatal case has been reported by Taylor. Large quantities of tar have, however, sometimes been taken without apparent ill effect. Children and young persons, as a rule, are most susceptible to its toxic action.

Treatment of Poisoning.—The treatment of poisoning by *pix liquida* is similar to that advised for poisoning by phenol. If the poisoning result from external applications, suspension of these will cause an abatement of the symptoms, accompanied by copious diaphoresis and more or less diuresis.

THERAPEUTICS.—Affections of Mucous Membranes.—The vapor of tar has been used largely for inhalations in diseases of the respiratory tract. In pulmonary disorders with excessive secretion tar, mixed with potassium carbonate (24 to 1) to neutralize the pyroigneous acid, may be placed in a cup over a water-bath heated by a spirit-lamp; the fumes of hot tar-water or wine of tar may be inhaled by means of a steam-atomizer; oil of tar diluted with some other oil or liquid petrolatum may be used in an atomizer, or the vapor from heated tar may be inhaled. Such inhalations are by many considered of value in *bronchitis*, especially in the *subacute* and *chronic* stages, and in "winter cough." In the *bronchorrhea* of *phthisis* they have also proven useful. In connection with these inhalations tar may be given internally in the form of pills or capsules (2 grains—0.13 Gm.) in milk or beer, or as tar-water (1

to 2 pints—500 to 1000 c.c.—daily), or wine of tar (1 to 4 ounces—30 to 120 c.c.). If administered independently of inhalations, 5- to 10- grain (0.3 to 0.6 Gm.) doses of tar may be given.

In *obstinate diarrhea* H. C. Wood has recommended a mixture of tar made as follows: Add a pint (500 c.c.) of tar to a gallon (4 liters) of lime-water, and allow this solution to stand a week, stirring it every few hours. Decant the clear liquid and percolate it through powdered wild-cherry bark, allowing 1 ounce (30 Gm.) of the bark for each pint (500 c.c.) of the liquid used. The dose is 2 fluidounces (60 c.c.).

External Uses.—In cutaneous disorders, especially those in which the mucous layer is principally involved, tar is an effective remedy. In *eczema* and *psoriasis* the tarry preparations are most effective when applied directly to the disease surface. In *eczema* tar gives the best results when applied after the subsidence of active inflammation; the special indication for its use is a condition of subacute inflammation accompanied by a dry, scaly surface, with more or less hyperemia and itching, and with inflammatory products still remaining in the tissues. It is best to begin with a mild preparation: Tar ointment, 1 part; zinc ointment, 3 parts. Stronger applications may be made later. The applications of tar may be continuous or intermittent. The drug is best avoided in involvement of the face, as it tends to stain the skin.

In the *dry chronic eczema of children* the following is useful: Tar, 1 part; precipitated sulphur, 1 part; zinc ointment, 16 parts. Mix and apply night and morning (Hare).

Bulkeley advises the use of liquor picis alkalinus in sluggish *chronic eczema*. The same preparation, or tar in the form of soap or ointment, may be used in the treatment of *scabies*, *tinea capitis*, and *lepra*. In *eczema* of a *subacute* or moderately inflammatory type a lotion containing $\frac{1}{2}$ to 2 ounces (15 to 60 c.c.) of liquor carbonis detergens to the pint (500 c.c.) of water is often very useful (Stelwagon).

For *psoriasis* tar may be used as a stimulant in the same manner, but it is less

employed than formerly, having in part been superseded by chrysarobin.

Care should always be taken at first, in applying tar, lest it excite dermatitis or acne picealis. Some skins are intolerant of it; some other remedy should then be substituted. A mild and relatively safe ointment for beginning tar treatment is one consisting of 1 or 2 drams (4 to 8 c.c.) of liquor carbonis detergens mixed with zinc ointment, enough to make 1 ounce (30 Gm.) (Stelwagon).

In **prurigo** tar is often valuable. A lotion of $\frac{1}{2}$ to 2 drams (2 to 8 Gm.) of tar to the pint (500 c.c.) often controls itching satisfactorily. One consisting of 1 to 3 drams (4 to 12 c.c.) of liquor carbonis detergens to the half-pint (250 c.c.) of water may prove even more useful. In **pruritus ani** a weak tar ointment will often afford relief.

A useful application to hemorrhoids is the following: Tar and extract of belladonna-leaves, of each, 45 grains (3 Gm.); glycerite of starch, 1 ounce (30 Gm.). This is to be applied morning and evening.

Tar ointment in full strength, or at first diluted (1 part to 3 of petrolatum), may be of service in **lichen, comedo, syccosis, pemphigus, lupus erythematosus, and lupus vulgaris**. Stern has observed that, when tar is allowed to stand in a warm place for several weeks, it separates into two layers, the upper of which is thin, syrupy, and devoid of irritant properties; an ointment prepared with this is advised when a mild effect is desired.

Duschkow-Kessiakoff (1915) has used tar with satisfactory results as a wound dressing. He pours it into all the wound recesses and then covers the wound with gauze. A favorable germicidal effect results and frequent change of dressings is rendered unnecessary.

LYSOL.—Lysol, introduced in 1889, is an antiseptic preparation made by dissolving in fat, and subsequently saponifying with caustic potash and alcohol, that part of tar-oil which boils between 374° and 392° F. (190° and 200° C.). It occurs as a clear, brown, oily-looking liquid, having a feeble, aromatic, creosote-like odor. It contains 50 per cent. of cresols, and is miscible with cold water, forming

a clear, soapy, frothing liquid. If it is mixed with boiling water, or its solution in cold water boiled, a cloudy mixture is formed. Lysol is also soluble in alcohol, chloroform, glycerin, etc. According to McClintic, lysol is, in tests by the Rideal-Walker method, 2.12 times as strong as phenol in the absence of organic matter, and 1.57 times as strong in the presence of organic matter (as is the case in practical disinfection). With the Liquor cresolis compositus, U. S. P., crude carbolic acid, creolin, and trikresol the corresponding figures were 3.00 and 1.87, 2.75 and 2.63, 3.25 and 2.52, and 2.62 and 2.50, respectively.

Poisoning by Lysol.—In spite of the alleged low toxicity of this preparation, numerous cases of poisoning by lysol, either from absorption when locally used, or from ingestion by mistake or for suicidal purposes, have been reported. Most of the cases of poisoning from local use have followed intra-uterine irrigation in the puerperium, the chief symptoms being slow pulse, shallow respiration, and cyanosis. Signs of acute hemorrhagic nephritis and of cerebral or peritoneal irritation have also been noted. In poisoning by ingestion the local destructive damage is seldom sufficient to cause death. The symptoms include a promptly appearing stupor, followed by cardiac and respiratory depression, and sometimes unconsciousness and death. The mucous membranes may be stained grayish white or light brown.

The treatment of poisoning by ingestion consists in washing out the stomach until the washings no longer smell of lysol, administration of $1\frac{1}{4}$ pints (600 c.c.) of milk (Blumenthal), a repetition of the **gastric lavage** some time later, and the use of **stimulants** and **external heat** as required. If some hours have elapsed since the ingestion of the poison, **calcined magnesia** should be given (Kirchberg). If the patient survives the first grave symptoms, the prognosis is relatively favorable, and when the poisoning does not end fatally, organic lesions are rarely left behind.

Therapeutics.—Lysol is widely used for **disinfection of the hands and instruments**, particularly in obstetric and gynec-

cological practice. The hands and fore-arms are scrubbed for 5 minutes with a 3 per cent. solution of lysol in hot water, the nails cleansed, and the hands then scrubbed for 3 minutes more in fresh solution and rinsed in sterile water. Before and after obstetric examinations a 2 per cent. solution may be used in place of soap. A 1 per cent. solution (roughly, 1 teaspoonful to the pint) may be used as a vaginal douche preparatory to examination in labor. For intra-uterine irrigation after curettage or for the patient's own use as a cleansing **vaginal douche** a 0.5 per cent. solution (1 teaspoonful to the quart of hot water) is suitable. Instruments may be disinfected without injury by cleansing with a 2 per cent. solution, then boiling for 5 minutes in a 1 per cent. solution with a little sodium bicarbonate. Recent **wounds** may be washed or irrigated with a 1 per cent. solution in hot water, and a 2 per cent. solution used for cleansing **chronic ulcers** and irrigating **abscess cavities**. In **disinfection** of the walls and floors of rooms lysol ranks with creolin, tricesol, and may be used in 1 to 3 per cent. solution. The preparation has also been used for preparing fields of operation, as a lubricant for the examining finger and instruments ($\frac{1}{2}$ dram to 2 ounces of glycerin), on vaginal tampons (same ratio), as a dressing for **burns** ($\frac{1}{4}$ to $\frac{1}{2}$ per cent. solution), as a mouth-wash or throat spray or gargle ($\frac{1}{2}$ to 1 per cent.), in **bromidrosis of the feet** (soaking in a 1 to 2 per cent. solution), in **mucous colitis** (enemas of $\frac{1}{4}$ per cent. solution), in skin affections such as **erysipelas** and **lupus erythematosus** (2 or 3 per cent. solution), and internally in **indigestion** with abnormal fermentation in doses of 1 to 5 minims (0.06 to 0.3 c.c.) after meals. According to some, the official *Liquor cresolis compositus* is practically identical with lysol in its action and uses.

PIXOL.—This disinfectant is made by dissolving 1 pound of green soap in 3 pounds of tar and slowly adding a solution of a little more than 3½ ounces of either potassium or sodium hydroxide dissolved in 3 pints of water. This makes a syrupy fluid which, in 5 per cent. dilution, may be used for **disinfecting linen**

and the hands. **Dejecta** may be **disinfected** with a 10 per cent. solution, which is said to be fatal to the pus organisms and those of **typhoid fever**, **cholera**, and **anthrax**. S.

TARAXACUM.—*Taraxacum*, U. S. P. (dandelion, blow-ball, lion's tooth) is the dried root of *Taraxacum officinale* (fam., Cichoriaceæ), gathered in the autumn. It is a well-known common perennial of America and Europe, bearing a flower having a yellow head of flowers on a slender peduncle, from a cluster of radial leaves. All parts of the plant contain a milky, acrid juice, which exudes when the plant is bruised or cut. The active principles are taraxacin and taraxacerin; the former is soluble in hot water, the latter in alcohol. The root also contains inulin, mannite, and resin.

PREPARATIONS AND DOSES.—*Taraxacum*, U. S. P. (the root). Dose, 2 drams (8 Gm.).

Extractum taraxaci, U. S. P. (solid extract). Dose, 5 to 20 grains (0.3 to 1.3 Gm.).

Fluidextractum taraxaci, U. S. P. (fluid-extract). Dose, 1 to 8 drams (4 to 30 c.c.).

Infusum taraxaci (dandelion tea—unofficial)—1 to 8 of boiling water). Dose, 1 to 2 ounces (30 to 60 c.c.).

PHYSIOLOGICAL ACTION.—The preparations of taraxacum are bitter; they stimulate the digestive secretions and act as a bitter tonic. It is a feeble hepatic stimulant, somewhat laxative, and very feebly diuretic.

THERAPEUTIC USES.—Taraxacum was chiefly used in **atonic dyspepsia** and **constipation** associated with **torpidity of the liver**, and also in **catarrhal jaundice** and **hepatic congestion**. It has no specific action in hepatic disorders, but is often combined with other remedies which are potent. Its diuretic effect is too feeble to be available. The fluidextract is a good vehicle for nitrohydrochloric acid, ammonium chloride, or potassium iodide. W.

TARTAR EMETIC. See ANTI-MONY.

TELANGIECTASIS. See BLOOD-VESSELS, TUMORS OF.

TENDONS, BURSÆ, AND FASCIÆ, DISEASES OF.—DISEASES OF THE TENDONS: ACUTE TENOSYNOVITIS.

—Inflammation of a tendon or tendon sheath, also termed **theclitis** and **tenosynovitis**, is the result of a traumatism, which may or may not prove suppurative. Often, however, the trauma gives rise to suppurative inflammation, owing to the invasion of pyogenic bacteria, the result in some cases of insufficient attention to antisepsis when the wound is dressed, carelessness on the part of the patient, or the presence near the injury of a suppurative process. It may also be caused by repeated, though slight, contusions, such as those to which the hand is exposed in many occupations and sports. Acute tenosynovitis may also appear as a complication of influenza, syphilis, gonorrhea, and rheumatism.

SYMPTOMS.—In non-suppurative cases there are pain, tenderness on pressure, and swelling. A distinctive sign is that the inflammatory roughening along the tendon-sheath gives rise to a moist crepitus, which tends to disappear as the swelling increases. The suppurative cases differ from the non-suppurative, in that the swelling is greater, more painful and pulsatile, dusky red, and far more tender. The suffering may be very great. General sepsis occurs not infrequently. The symptoms vary, however, with the location of the morbid process, the two most exposed areas in this connection, the palm and fingers, giving rise to the two conditions described below.

Palmar abscess may be due to repeated contusions, and also to extension of a tenosynovitis of the fingers, especially when the abscess is located on the flexor side of the little finger and the thumb, owing to the connection of their synovial sheaths with the general sheath common to the tendons of the palm. The three other fingers, as is well known, possess separate sheaths. When suppurative inflammation is present in the palm, high fever may occur, and the pain is severe in proportion to the resistance of the overlying tissue. Here, again, the pus may burrow in various directions or insinuate itself between the metacarpals to the dor-

sum, and, passing beneath the annular ligament, reach the tissues of the forearm and beyond. Death has been known to ensue in such cases from pyemic infection. The palmar lesion may, in turn, become aggravated; necrosis of the carpus may occur and dangerous hemorrhages suddenly appear through involvement of a large vessel in the suppurative process. A clawed, stiff hand may result.

Felon, or Whitlow.—The term "felon" is often applied to a superficial inflammation of the finger or toes around the nail. This variety has been treated under **NAILS, DISEASES OF**, vol. vi. The form considered here is that to which "felon" more properly belongs: inflammation of the deeper tissues, including the tendon and its sheath of the distal phalanx. This is usually due to traumatism,—a blow or crush,—and develops soon after the receipt of the injury, though sometimes only toward the end of the second day. Severe pain, heat, throbbing, and more or less fever betoken the presence of quite an acute inflammatory process. The pain becomes extremely severe and almost unbearable if surgical measures are not resorted to. If the abscess be allowed to proceed without relief, extension toward the hand may follow or the pus gradually works its way toward the surface, forming a volcano-like mass, which, upon healing, leaves the thumb deformed—sufficiently in some cases to impair its usefulness.

TREATMENT.—The treatment depends, of course, upon the condition presented at the time the case is seen. In its incipient stage an acute tenosynovitis, especially in non-suppurative cases, may sometimes be cured by **rest, elevation of the part**, and application of **cold compresses, iodine, blue ointment, ichthyol**, prolonged baths in a solution of borate of sodium, or hot antiseptic fomentations, especially if small doses of iodide of potassium are given internally—with copious draughts of water. Bier's hyperemia method may also be used with advantage. In the vast majority of cases, however, such a favorable result is not reached, and the inflammatory process proceeds to supuration. A free incision including the tendinous sheath, exposure of all sinuities that appear suspicious, irrigation and

drainage, all performed under strict antiseptic precautions, and dressing with **hot antiseptic fomentations**, represent the only safe procedures. Thoroughness at this time avoids a repetition of the operation, while the likelihood of a deformity is greatly reduced. General anesthesia is to be preferred.

According to Kanavel, incisions are best made in the fingers, either upon one or both sides of the tendon sheath over the length of the shaft of the middle and proximal phalanx, avoiding the joints, and into the proximal end of the sheath or the lumbrical spaces to provide drainage there. The ulnar bursa is best treated by splitting it throughout its length, cutting upon the ulnar side. The anterior annular ligament should generally be cut. This is commonly supplemented by incisions upon the radial and ulnar sides of the forearm above the wrist-joint, and on a level with the flexor surface of the bones. Through-and-through drainage is then carried out under the flexor profundus tendons. An ulnar incision may be sufficient. If the pus has invaded the forearm, an ulnar incision is made at the middle of the forearm between the flexor carpi ulnaris and the flexor sublimis, or between the flexor carpi ulnaris and the ulna. Incision of the flexor longus pollicis sheath is made from a finger-breadth below the anterior annular ligament to the end of the sheath. Opening may be made above the anterior annular ligament, the upper half of which may be cut, or drainage may be instituted above the wrist by the lateral incision mentioned under ulnar bursal infections. In the *after-treatment* the **Bier constrictor** is used for 24 to 48 hours, **hot moist dressings** for 2 to 4 days, followed by **dry dressings**, hand being held in **overextension** by **splint**, daily **manipulation of joints and muscles** after the immediate danger of systemic infection has ended.

In **palmar abscess** the danger of delay is especially great. A **free incision** under **general anesthesia** is imperatively demanded, the line followed being that of the metacarpal bone nearest the abscess. In doing this, however, the location of the palmar arch should be borne in mind, and the artery avoided. Should it accidentally be cut, both ends should be carefully

picked up and ligated. In some cases, the abscess opens spontaneously early in the history of the case. The pus, however, originates in small superficial abscesses, which sometimes form in addition to the deeper and greater one, and rupture early through the pressure exerted from below. They tend to mislead the operator by causing him to delay the evacuation of the main abscess. Several palmar incisions and **counter-openings** are necessary at times to insure **through-and-through drainage**, introduce the tubes, etc. **Hot fomentations** should then be applied and the part placed in a **splint**. When granulations appear, **dry dressing** should be substituted. The danger involved not only includes extension of the purulent process beyond the hand, but also destruction of the tendons of the latter, followed by permanent flexion of the finger: the "*main en griffe*."

In **whitlow**, or **felon**, the general indications are similar, but the chances of arresting the inflammation promptly are greater if the case is seen early. Any of the general indications given above may be resorted to. When, according to Macfarlan, there is as yet no pointing or definite formation of pus, a **wet dressing of mercuric iodide**, 1 Gm. (15 grains); **potassium iodide**, 4 Gm. (1 dram), and water, 100 c.c. (3¼ ounces), will usually reduce the course of the affection and frequently abort it. This may also be effected sometimes by keeping the finger wet with **alcohol**, diluted with an equal quantity of **camphor-water**. A thin bandage well soaked with the solution is wrapped around the finger and **oiled silk** is carefully wrapped around the whole to prevent evaporation. A strong **solution of borax**, or a **bichloride solution** 1:3000 may also be used in the same manner, but phenic acid solutions should not be employed, several cases of gangrene having been ascribed to their use.

In superficial felons, White softens the area with an antiseptic solution, **pares off** the **cuticle** with a sharp bistoury to free the pus without infecting the deeper tissues. If the suppuration is subcutaneous, however, **free incision** is necessary, but the tendon-sheath and periosteum should be strictly avoided for the same reason.

The after-treatment is the same as for palmar abscess (see preceding page). The distal phalanx may be found necrosed; hence the deformity left in so many cases of whitlow.

If necrosis is present, dead portions of the bone should be removed; but little apprehension need be felt, since it rarely extends beyond the epiphyseal line. In the two lower phalanges, however, necrosis is of more serious import; the dead bone must either be removed or the finger amputated, according to the amount of osseous tissue involved.

CHRONIC TENOSYNOVITIS, or THECITIS, may occur as a result of the acute form, or be caused by traumatism, rheumatoid arthritis, and syphilis, but in the majority of cases it is due to tuberculosis of the sheath. In the latter condition nodular, more or less spindle-shaped swelling following the long axis of a tendon is formed, which contains, besides liquid, small bodies resembling rice or melon seeds; hence called "riziform" bodies. These are either buried in the sac-wall or float freely in its liquid, and are found to contain, upon microscopic examination, tubercle bacilli. The local disease may assume a fungous form, and not only destroy the tendon, but spread to neighboring tendons and joints. *Tuberculous tenosynovitis* usually develops near the wrist, and much less frequently in the tendons of the fingers, knee, and ankle. It gives rise to but little suffering, and, as a rule, interferes but slightly, if at all, with the functions of the affected extremity until well advanced. Its progress is, as a rule, quite slow. It may, if the health of the patient is materially improved, disappear spontaneously, or become fungous after penetrating the superficial tissues, as does typical tubercular abscess. It may occur as the complication of a joint tuberculosis. The riziform bodies facilitate diagnosis by conveying to the finger exerting pressure upon the swelling a crepitation recalling the presence of gravel.

Treatment.—The *non-tuberculous* form should be treated by rest and local applications of *ichthyol*. When the acute phenomena have disappeared, the *ichthyol* applications should be supplemented by gentle massage, hot and cold douches, or

hot-air baths, the motions of the part being reduced by strapping.

In the *tuberculous* form, a tendency to relapse renders it imperative to eliminate thoroughly the local trouble and to treat the general dyscrasia as well. When the sac is purely cystic—i.e., devoid of fungoid vegetations—a small incision, followed by washing out with saline solution and the injection of a solution of *iodoform* in olive oil or in ether, will often suffice. When riziform bodies are present, however, more effective means are necessary, since they represent as many foci for tubercle bacilli. The sheath should be laid open and its interior surface and the tendon thoroughly cleared with the *curette*. Fungoid vegetations still further complicate the case, and, unless every vestige be removed, including affected external tissues, sheath, and tendon, recurrence is sure to follow. **Asepsis** is of the greatest importance, general toxemia occurring readily through the lymphatic system if proper precautions are not taken. **Bier's method** and the **X-rays** have given good results. The general treatment should include the administration of **creosote**, **out-of-door life**, and other measures indicated in pulmonary tuberculosis.

INJURIES OF TENDON: DISPLACEMENT OR DISLOCATION.—A tendon is sometimes displaced from its normal position by a violent motion in which its normal axis of traction is more or less departed from, the sheath being torn. Often it immediately returns to its normal position, but sometimes it does not, and local pain, with impairment of motion, results. The displaced tendon can usually be felt, and its normal situation be the seat of a depression. Or it may be felt to slip out of its groove when it contracts. The *peroneus brevis* probably shows the greatest predilection in this direction, and comparatively often slips out of its groove, being felt over the malleolus when the foot is flexed and extended. Displacement is most frequently observed in connection with dislocations and fractures, and in the latter a tendon may insinuate itself between the fragments, and thus prevent approximation and union. Tendon dislocation is often associated with chronic joint disease, notably rheu-

matoid arthritis, which may give rise to displacement of the long head of the biceps.

Treatment.—By gentle manipulation with flexion or extension of the extremity, as required to reduce the tension upon the tendon, restoration to its normal position is usually obtained. Once displaced, a tendon is liable to again leave its bed. A suitable **retentive dressing** and bandage should be so applied as to hold it *in situ* until thorough repair of the torn sheath has occurred. If this fails, and after a few weeks the displacement recurs, the edges of the **torn sheath** should be **freshened** and **sutured to the tendon**. Or, if the tendon fails to remain in its groove, a **halter** can be made by incising the periosteum and suturing it over the tendon. **Passive motion** is then begun after a week has elapsed.

RUPTURE.—Under the influence of a sudden effort the contraction of a muscle may exceed the resistance of the fibers of its tendon, and the latter gives way. The tendon of the rectus femoris above and below the patella, the tendo Achillis, the tendon of the triceps near the olecranon, and that of the biceps near the forearm are those which are most exposed to this accident. The rupture is usually complete, and a cavity may readily be felt where before the tendon was continuous, the gap being increased by extension. When the knee is the seat of rupture there is marked effusion in the joint, and the patella is drawn upward: a deformity very readily noticed. There is a distinct snap when the rupture occurs, immediate loss of power in the limb, and sometimes severe pain.

Treatment.—Approximation of the ends by full extension of the limb, application of **retention bandages** and **splints**, and **immobilization** of the limb at once suggest themselves. If these can be carried out satisfactorily, perfect union occurs at the end of two months, and, with a little care for a few weeks subsequently, perfect cure ensues. This happy result is not always obtained, however; in the majority of instances the tendon-ends cannot be held together by simple means, especially when the muscle draws the proximal end away to such a degree that traction has to be

exerted to bring its extremity down to the lower. In such a case, therefore, it is better to **suture the ends**. This is especially important when the traction is due to the action of large muscles, such as those of the calf or thigh. Under careful asepsis this can now be done without the least danger, even at the knee. The incision should, if possible, be made to one side of the tendon, and not over it, to reduce the chances of adhesion. Rupture of the tendo Achillis is sometimes managed with



Elongation of the tendo Achillis. (Poncet.)

difficulty, or tends, if union is obtained, to cause pes equinovarus. Poncet (see annexed illustration) avoids this by cutting the edges of the tendon zigzag fashion to elongate it, as shown in the cut, or by Czerny's method, described below.

WOUNDS OF TENDONS.—Tendons are susceptible to traumatism of any kind, but their density causes them to resist penetration. Puncture wounds, therefore, are seldom met with, the point of the instrument being diverged in the majority of instances. The sheath, however, is usually torn, but it quickly recovers, if pyogenic organisms have not been introduced. Incised wounds are of little moment unless the entire tendon is cut, when, with

a snap, it assumes the relations outlined under Rupture. In the latter, however, the solution of continuity being subcutaneous, pathogenic bacteria are not introduced; in rupture due to the thrust of a knife, sword, chisel, etc., the contrary is likely, and the surgeon should always assume that he is dealing with an infected wound. He will thus insure an early recovery in all cases.

Treatment.—Whatever be the cause of the laceration, the ends should be **stitched** with buried catgut sutures, care being taken that the ends be carefully placed in apposition, or, better still, overlapped. It is sometimes necessary, in order to recover the proximal end, to slit the sheath, or to free it some distance from its surroundings to do this. The suture holds best when passed through transversely about one-third inch above each free end. In some cases, as in bullet wounds, much of the tendinous substance has been carried away, while the softer and more elastic sheath remains, at least to a greater extent. If the ends of this are united, so as to form a continuous canal, a new section of tendon will be formed if the vitality of the sheath was sufficient.

Lengthening of the tendon may also be resorted to. Either Poncet's or Czerny's method may be resorted to. Poncet's is described above. Czerny's consists in cutting the tendon half-through some distance above the end, then longitudinally toward the latter until near it. The portion thus partly detached is then turned down toward the other free end of tendon and sutured to it. If too great length of tendon has been lost, an **animal tendon** may be transplanted and sutured to both free ends. This forms the basis of a new tendon, the animal tendon being usually absorbed.

DISEASES OF THE BURSÆ.—The bursæ, or protective cushions developed in the cellular tissue, may be normally provided, or acquired, when certain parts, superficial or deep, are exposed to unusual friction or pressure. These may become inflamed through injury or overuse, constituting *acute bursitis*, or through continued irritation, constituting *chronic bursitis*. The bursæ often become involved in diathetic processes, rheumatism, gout, and syphilis especially.

ACUTE BURSTITIS.—An acute inflammation of a bursa may be serous or purulent, and, as stated, is usually due to injury. When located superficially there is marked swelling, redness, and local heat. When an inflamed bursa is situated in the deeper tissues, the swelling can only be detected with difficulty, if at all, and the pain, especially on motion, is severe. General febrile symptoms often appear when a deep bursa is involved, especially when there is a tendency to supuration, this being likely to extend. The inflammatory process sometimes extends to a neighboring joint, including the synovial sac, which is easily penetrated. The diagnosis can usually be established by judging the effects of motion. Extreme abduction or adduction of the humerus, for instance, causes severe pain, if the inflamed bursa is under the deltoid; when the bursa between the quadriceps extensor and the femur, or that under the ligamentum patellæ, is the seat of the inflammatory process, flexion of the leg upon the thigh becomes painful, through the pressure thus exerted upon the bursa.

Treatment.—Absolute **rest** in bed and **immobilization**, by placing the extremity in a **splint and pressure**, **elevation of the part**, and **cold or hot antiseptic fomentations**, **iodine**, **blue ointment**, or **ichthyol**, all afford considerable relief. If the active symptoms persist notwithstanding these measures, the sac should be **aspirated** if the fluid is **serous**, followed by pressure; or **free opening**, if **pus** be present, and the purulent discharge completely evacuated, and the interior of the sac is swabbed with **phenic acid**, then packed with **iodoform gauze**. Lugol's solution mixed with an equal quantity of glycerin and other solutions were at times injected, but the danger of involving the joints has caused them to be discarded.

CHRONIC BURSTITIS.—Chronic inflammation of a bursa is met with much more frequently than the acute form. It develops insidiously, is unattended by pain, and manifests itself only by marked swelling, which varies in density according to the thickness of the bursal wall. This becomes quite dense sometimes, and conveys to the touch a feeling of hardness suggesting bone. In some cases it may be

thin and the cavity be greatly distended with fluid. The harder bursa is usually separated into various cavities by thick, fibrous partitions, or the interior is studded with villous growths, which sometimes become detached and form riziform bodies. Occasionally it undergoes calcification.

HOUSEMAID'S KNEE.—This popular term is applied to chronic swelling of the prepatellar bursa, as a result of continued or repeated pressure while scrubbing, etc. It is located immediately at the knee, and the globular swelling projects anteriorly when the patient is sitting. It is usually quite large, the size of a small orange, and its wall being comparatively thin, it generally fluctuates. At times it becomes irritated through continued pressure and may become slightly painful, the limbs at the same time becoming somewhat stiff and weak at the knee. A similar condition of the olecranon bursa is known as **miner's elbow**, and another over the tuberosity of the ischium is termed **weaver's bottom**.

Treatment.—When **rest** and painting with **iodine**, or the application of **blue ointment**, or, again, **iodine cataphoresis** will fail to cure, **blistering** will sometimes procure it. In most cases, however, surgical measures are necessary. **Aspiration**, followed by **light massage**, is the simplest of these; if this proves insufficient, **incision** and **packing with iodoform gauze** should be resorted to. **Extirpation** may be performed if need be through a lateral incision.

BUNION.—This consists of an enlargement of the bursa over the metatarsophalangeal articulation of the big toe, but which may also present itself over other joints of the foot. It is often due to the pressure of ill-fitting shoes, which not only exert pressure upon the bursa overlying the articulation, but also tend to force the big toe away from its normal line and the metatarsal extremity of the second phalanx outwardly. The bursa thus finds itself pinched between the bone and the overlying leather. Bunions may cause but little trouble, when not compressed, but, irritated in the manner outlined, they become inflamed and at times exceedingly painful; the skin becomes

highly congested and tense; tumefaction occurs, accompanied by accumulation of fluid in the bursa; and locomotion becomes difficult. In some cases suppuration follows; the pus may then burrow through the bursal wall, give rise to cellulitis, and involve the metatarsophalangeal joint.

Treatment.—The shape of the footwear is of primary importance in the treatment of the cases. The inner side of the shoe should accommodate the bunion in such a manner as to avoid all pressure, while the great toe should have ample room to project in a straight line from the foot, and not be pushed toward its median line. Pointed shoes are pernicious in this connection. A change of footwear is sometimes sufficient to bring about recovery. **Bunion plasters**, available in the shops, are very helpful. The local treatment is that of bursitis. **Iodine** painted over the projection is advantageous. **Ichthyol** and **blue ointment** are also effective. When the applications become irritating, a salve of equal parts of **cosmoline** and **tannic acid**, as advised by Gross, is useful.

Tapping and the **evacuation of pus** by incision sometimes become necessary. These are safe procedures if done under **strict asepsis**. According to Robert T. Morris, the older operations often resulted in stiff joint and other discomforts. A simple **operation** often suffices. It consists in a longitudinal incision from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in length along the inner surface of the extensor tendons; the site of the hyperostosis is exposed, and a sharp chisel separates the button of the bone readily from the head of the metatarsal bone. The open bursa can then be trimmed out with a pair of scissors without difficulty, and when the wound is sutured and the skin pressed against the surface of the bone from which the button is removed, it becomes quickly adherent, and the bunion is at an end. The patient is allowed to walk in from 10 to 12 days.

C. T. Mayo "removes the head of the metatarsal bone and two-thirds of the hypertrophy on the inner side, then turns the bone into the joint area in front of the bone. He sutures this bursa in place and thus obtains a synovial membrane which becomes satisfactorily movable."

GANGLION.—This name is given to a rounded tumor usually about the size of half of a hazel-nut, which generally forms on the back of the hand, but also on the dorsum of the foot. It may be soft and yielding when pressed upon, or exceedingly hard, suggesting the presence of an osteoma. It is not painful even under pressure, and gives rise to no inconvenience. When, however, as in the case of pianists, the fingers are moved rapidly and with power long periods at a time, a sensation of weight or stiffness is experienced and occasionally slight pain. Some pathologists consider it as a pouch-like projection of the synovial membrane of a joint in the majority of cases, and rarely arises from a tendon-sheath. The prevailing view, however, is that it is the result of a traumatic degeneration of connective tissue adjoining a joint or tendon, the alveoli of which dilate and form a cyst which contains a thick, honey-like liquid.

Treatment.—Pressure or a sharp blow causes the sac to rupture, the liquid being promptly absorbed, but this rather unsurgical method is now generally supplanted by **subcutaneous incision** with a small bistoury, under strict antiseptic precautions. The small incision being made, a piece of **iodoform gauze** is placed over the sac, and, pressure being exerted with the thumb, the fluid is quickly evacuated and dispersed. A few drops of **iodine** injected into the ganglion sometimes causes its absorption. Large tendinous tumors sometimes require **excision**.

CONTRACTION OF TENDONS AND FASCIA.—The subject of **CONTRACTURES**, including **TENOTOMY**, having already been considered in the sixth volume, page 467, only special conditions of this class will be reviewed under the present head.

DUPUYTREN'S CONTRACTURE.—This is an obstinate form of contraction affecting principally the palmar fascia, prolongations of which, as is well known, run by the side of the fingers, and are attached to the periosteum of the first phalanx. By contracting, these prolongations gradually cause the fingers to close upon the palm of the hand and to remain in this position permanently. The ring-finger is usually that first involved, but in the majority of cases the three fingers on

the ulnar side of the hand are contracted, the index finger and thumb rarely. Either hand may be affected, but occasionally both become so flexed as to paralyze their usefulness. It usually begins as a small, hard mass near the metacarpophalangeal articulation; contraction of the corresponding finger begins and proceeds until the nails fairly dip into the tissues of the palm.

Dupuytren's contracture has been traced to many causes: the rheumatic and gouty diathesis and other general condition; but in practically all cases there is a history of local injury of a persistent kind, such as the continuous forcible handling of a certain tool, the pressure of a cane-knob, etc. Again, it is occasionally observed after prolonged illness in which the general vitality of the organism has been severely taxed. It is rarely observed before middle age, and almost always in men. The patient is usually possessed of good general health.

Treatment.—The progress of the contraction is steady until the hand becomes totally crippled, and the only effective means at our disposal are surgical. Efforts at extension are unavailing, but, when this is tried, thick elevations are seen to form in the palmar cavity and to push its superficial tissues upward. It is upon these bands that efforts at liberation should be concentrated. A small tenotome should be introduced at various places under each, and the **attachments** of the **bands** to the overlying skin so freed as to permit of full extension of the fingers. A **splint** should then be applied and worn, not only until recovery of the wounds, but during several days subsequent thereto. Then daily **passive motion** and **massage** should begin, coupled with a mild **galvanic current**, until the motions of the fingers have been completely recovered.

In some cases it is necessary to obtain complete extension, to resort to **removal of the hardened palmar fascia**. An incision is made along the length of each hand, and the skin is carefully dissected up from the latter. This being done, the hard tissues constituting the band proper are separated from their surroundings, then cut out as completely as possible.

Keen's method does this most satisfactorily. He makes a V-shaped incision, the apex of which is upward; raises the flap, then dissects out the contracted tissues. These cases need close watching, since the danger of recurrence is always great, and **passive motion, massage, etc.**, should be resumed as soon as there is the least evidence that the affection is returning.

Good results have been credited to a combination of **sodium salicylate** and **thiosinamine** used hypodermically. Gilbert obtained good results from **thyroid gland** in 1½-grain (0.1 Gm.) doses, *t. i. d.*, given a long time. **Radium** has also been praised.

TRIGGER-FINGER.—Two groups of this disorder may be recognized: the organic and the functional. The causes for the organic variety may be found in the tendons, fascia, muscles, or in conditions which will tend to modify the directions of muscular action, and the movements of flexion and extension. The functional class may be reflex, following local irritation, or may be a local manifestation of certain neuropathies. Cases of this class may arise independently of any voluntary movements.

The disease consists of a peculiar and sudden locking of the finger when it is flexed or extended to a certain point. It remains in the position acquired notwithstanding ordinary efforts to bring it to another position. A powerful voluntary effort sometimes succeeds, however; but in some cases the assistance of another person is necessary. The disorder is usually limited to one finger, the middle finger being that most frequently affected. The majority of cases are observed in females.

Treatment.—The treatment of trigger-finger consists in the application of **iodine, electricity, massage, passive motion, and fixation of the finger** by means of a **splint**. Inveterate cases have been treated by **operation**, which usually consists in removing whatever obstacle to free movement exists.

In a personal case, the writer painted the part with **iodine**, inserted a fine bistoury in the flexure crease, and, pressing the point down to the tendon, drew it along for a half-inch.

Relief was instantaneous and final. A small pad of boric gauze made pressure for two days and the trouble was cured.

The tendon is easily located by thumb pressure at the crease, and is not covered by nerve or vessel. Cutting the tendon fibers lengthwise (if one wished to cut deeply, which is not necessary) would in nowise damage the tendon. Robert Abbé (*Medical Record*, March 7, 1914).

If an underlying cause, like rheumatism or gout, is ascertainable, proper general methods, the **salicylates, colchicum, etc.**, are to be instituted. In cases accompanied by pronounced paresthesial phenomena, the use of **ergot** may be tried.

TENDON TRANSPLANTATION.—In the treatment of paralysis, especially spinal paralysis in children, transplantation of tendons, first done by Duplay in 1876, is an effective procedure. One method consists in choosing a healthy muscle which can be spared, dividing its tendon, and suturing the central portion to the tendon of the paralyzed muscle. A second operation consists in dividing the whole or a part of the tendon of the paralyzed muscle, and suturing the peripheral end to the tendon of a functionally active muscle. A third consists in splitting the tendon of a functionally healthy muscle into two parts, and attaching one part to the tendon of the paralyzed muscle. A fourth proceeding is the suturing of a split-off portion of a healthy muscle-tendon to a properly chosen site in the periosteum.

The success of the operation depends upon a correct diagnosis, and on the proper correction of the displacement. This is better carried out by a lengthening or shortening of tendons than by simple tenotomy. Poncet's operation for the former (illustrated on page 507) is effective; it consists in cutting into the tendon in step shape. In dealing with broad tendons two longitudinal incisions of equal length may be made, one 1 cm. higher than the other. From the lower end of the second, and from the upper end of the first, transverse incisions are made in opposite directions. Thus, the tendon is lengthened by the sum of the two incision

lengths. The shortening operations are either excision of a part of the tendon and end-to-end suture, or simple division and suturing the ends overlapping one another. Tendon surgery has been greatly advanced by a skilled combination of tendon transplantation with tendon lengthening or shortening.

Guiding principles in tendon transplantations: (1) perfect asepsis; (2) attachment of the transplanted tendon to the bone or periosteum is always more satisfactory than attaching it to another tendon or other soft tissues; (3) the tendon must be stretched moderately tight before being secured; (4) it must be fastened with suture material that will maintain its hold for several weeks; (5) a covering of subcutaneous tissue should be brought over it before the skin is sutured; (6) about six weeks should elapse before the transplanted tendon is allowed to function, so that its new attachment may become sufficiently strong; further, the muscle should be systematically developed by massage and exercises, and be carefully protected by mechanical means from overstrain for several months after the patient begins to use it. Galloway (*Surgery, Gynecol., and Obst.*, Jan., 1913). S.

TETANUS.—SYNONYMS.—

LOCKJAW, TRISMUS, and, when occurring in infants, TRISMUS NASCENTIUM or TETANUS NEONATORUM.

DEFINITION.—An acute or sub-acute infectious disease caused by the tetanus bacillus, and characterized by violent tonic spasms with marked exacerbations and remissions.

SYMPTOMS.—Following some injury, slight or severe, and usually ten days after—although longer periods of incubation have been noted—the first symptoms of tetanus appear. There are slight stiffness of the neck, and some rigidity of the muscles of mastication with interference with

the movements of the tongue. Often, however, the earliest signs are twitching spasms or “rheumatic” pains in the wounded region or extremity, sometimes limited to one or a few muscles; also jerking of these or other muscles after slight pressure, and a tremulous tongue. Violent headache and excessive yawning are also suggestive.

Very possibly the trigemini possess a special affinity for the toxin. The muscular contractions are very similar to those in yawning. This act consists in a slow inspiration accompanied by dropping of the lower jaw and followed by a short tonic spasm of the muscles of inspiration. B. Beer (*Wiener klin. Woch.*, Apr. 8, 1915).

Chilliness may be complained of, and the wound, if unhealed, is apt to become tender and painful.

The symptoms appear transiently and are slight at first. A day or so after the infection there may be restlessness, sleeplessness, distressing dreams, difficulty in urination and more frequent impulses, oppression in the chest, violent headache, drawn features, nosebleed, sweating, fatigue, excessive yawning, vertigo, darting pains at various points and chilliness. Sometimes a swelling of the injured limb, notwithstanding the limb is raised, tends to suggest tetanus; it feels hot but is not red, and the local arterial pressure is unduly high. There may be occasional local pains and in a day or so the lymph-cords appear red and the region is very tender. Single groups of muscles may be tonically contracted at first painlessly. Contracture and tremor may be noted in the injured limb, sometimes clonic twitching; more and more muscles gradually participate. In a hand wound, on grasping the forearm twitchings in the different flexor tendons may be felt. One of the first signs, the third day, is a persisting pain after the involuntary

contractions of the muscles induced by effort; later the muscles form a painful lump, disappearing after a time but returning anew if the part is touched again. The lymph-glands were swollen in several of the writer's cases, the inguinal glands in some resembling the findings with syphilis. In one the ulnar gland had to be excised under local anesthesia. Vertigo is an especially important early sign; also ocular symptoms and a spasmodic cough. The pulse is generally tense, slow and full. The hearing at first may be unusually acute, but later there is more or less deafness. Speech is slow. Evler (*Jour. Med. Assoc.*, from *Berl. klin. Woch.*, Sept. 21, 1910).

In 6 cases of localized tetanus, all wounded in battle, with preventive injections of **antitetanic serum**, the mode of onset was the same in all instances, pain suddenly appearing in one limb or in the neck without evident reason, and not always in the vicinity of the wound. Such a sudden apparently causeless pain in the limb of a wounded man is held always to suggest tetanus. Total or partial contracture of the painful limb soon follows. A rise in temperature may occur either at the outset or soon thereafter. Routier (*Bull. de l'Acad. de Méd.*, Nov. 30, 1915).

The writers have determined the incidence of tetanus in 150,000 French soldiers wounded in 1918. The rate was 0.06 per 1000 in the army zone, 0.19 per 1000 in the intermediate zone, and 0.30 per 1000 in the zone of the interior. These striking results are to be attributed to the **serum treatment** which had been systematized, with improvements in technique. Sieur and Mercier (*Bull. de l'Acad. de méd.*, Oct. 21, 1919).

As the disease gradually develops, the muscles of the jaw begin to exhibit marked tonic spasms—"locked jaw." The facial muscles are also often attacked, producing distortions of facial expression.

Pains and twitching in the muscles around a wound liable to be infected with tetanus germs calls for preventive injection of **antitetanus serum**. Trismus is by no means the first sign of tetanus, although it is the first unequivocal one. Blumenthal (*Med. Klinik*, Nov. 1, 1914).

The wounded are apt to ascribe to their wound the first faint symptoms of tetanus, so the physician must make special inquiry for slight "rheumatic" pains and stiffness in the wounded limb, fatigue in chewing, pains around the mouth and brief cramps in the chest muscles, like a "stitch in the side." Schneider (*Munch. med. Woch.*, Jan. 5, 1915).

The head is often drawn backward and the dorsal muscles become involved, causing backward bending of the vertebral column. As the spasm extends, the body may bend forward or laterally, according to the contractions in different muscle groups. The muscles of the hands, arms, and legs are comparatively little affected.

In tetanus acquired in war the muscles nearest the point of infection were the first involved. The superficial and deep reflexes were also found to be increased early in the infected extremity; thus stroking of the sole of the foot would often throw the leg into tetany while the opposite leg remained relaxed. Babinski's reflex and ankle and patellar clonus are at first local. A new symptom was increased nervous irritability to mechanical stimuli, as in tetany. The ulnar phenomenon was frequent, likewise tenderness at the base of the skull behind. All these signs were of much aid in making an early diagnosis. Goldscheider (*Berl. klin. Woch.*, Mar. 8, 1915).

Tetanus may not only be asymmetric, but practically unilateral. A man was wounded in the left forearm and then gradually the entire extremity became rigid. Next there developed unilateral left-sided spasm

of the face, and later the left half of the neck and trunk, with slight implication of the left lower extremity. Involution occurs in the inverse order. Harf (Berl. klin. Woch., Apr. 19, 1915).

Case of tetanus confined to a single extremity in a man of 28 who had sustained 3 wounds of the left thigh from a hand grenade. A metallic foreign body was removed on the next day and a preventive injection of 10 c.c. (2½ drams) of **antitetanic serum** given. Subsequent radiography showed 7 or more foreign bodies still imbedded in the tissues. Ten days after the injury brief and painful muscular contractions on the inner aspect of the knee were experienced, recurring about every 2 minutes. Later, all the muscles in the wounded area went into a cramp three or four times a minute. Two weeks after the start of the convulsions trismus was noted for the first time. The peculiar picture is ascribed to incomplete immunization, the bulbar centers having been protected and the disease expending itself upon the nerves or spinal segment of the injured area. Courtois-Suffit and R. Giroux (Bull. de l'Acad. de Méd., Jan. 25, 1916).

The slightest source of irritation, such as a light touch of hands or bed-clothes, moving the limbs, a breath of air, a loud sudden noise, will cause, so soon as the attack is well established, a severe clonic exacerbation of spasm. The muscles of the whole body violently contract, often with great interference with respiration and phonation, or with spasm of the glottis. The exacerbation subsides after a few minutes or sooner, to be repeated under the slightest provocation. In the intervals some tonic spasm of the muscles persists. During the paroxysms there is usually profuse sweating; the pulse rate runs up to 130 to 150; and in some cases

there is hyperpyrexia, 110° to 115° F. (43.3° to 46.1° C.) being seen in fatal cases just before death. There may be retention of urine from spasm, and in any case the secretion is scanty.

After the attack reaches its height, pain during paroxysm is most excruciatingly intense. The mental faculties remain unimpaired throughout the attack. Death may occur from asphyxia or cardiac dilatation during a paroxysm, or at later stages from exhaustion. The attack endures from a few days to several weeks.

Recurrence may appear in convalescence or after recovery under the stimulus of other bacteria. Such cases have been reported by Happel (*Münch. med. Woch.*, July 27, 1915) and Brandt (*Zentralbl. f. inn. Med.*, Sept. 4, 1915).

DIAGNOSIS.—In typical cases following injury no difficulty in diagnosis could arise. In *strychnine poisoning* the jaw muscles are not first affected; in the intervals between the paroxysms there is no stiffness nor tonic spasm; the symptoms develop rapidly, not gradually, as in tetanus; and the history of the case is different.

The *head tetanus* of Rose, with its well-pronounced trismus, dysphagia, and facial paralysis, might be mistaken for rabies, but in the latter trismus and involvement of neck- and back- muscles are wanting.

Case of tetanus in a child of 10, who had very badly decayed teeth, and no other lesion allowing entrance. Animal inoculations and culture experiments showed that tetanus germs were present in the tooth cavity. Luckett (*Med. Rec.*, Feb. 19, 1910).

Case of the rare head tetanus, the 7th reported in the United States, and the 94th in literature. In all but 2 cases the affection followed a head

wound, and the tetanus bacillus was usually found. Lymphatic absorption being limited in this area, the resulting tetanus is benign. Brown (*Annals of Surg.*, Apr., 1912).

Case of tetanus of the head due to caries of a tooth, in a young man, the tetanus developing with facial paralysis and trismus. The reflexes were exaggerated, but there were no other symptoms except that the larger muscles were slightly tender and showed a trifle of contraction. The mortality of head tetanus is only 36 per cent. Mégevand (*Revue méd. de la Suisse rom.*, Oct., 1913).

In *tetany* the nature of the spasm is different, and it especially involves the hands and feet.

In *hysteria* some symptoms of tetanus may be simulated, but the presence of other hysterical phenomena and the history of the case should preclude error. A bacteriological diagnosis should be made by means of cultures and stained preparations from pus of the wound and from the earth of the locality. Mice inoculated with pus from a tetanus-infected wound will die within a few days: a fact which may be used in diagnosis.

ETIOLOGY.—Newborn children are very susceptible. After the first month of life, however, infants seem less liable to the disease than adults, the period of greatest danger being from 30 to 45 years. In general, males are more frequently affected than are females, and the negro races are more susceptible than are the white. Horses, cattle, sheep, and other animals are also attacked.

All forms of the disease are much more common in hot countries than in temperate climates. The disease is often especially frequent in certain localities (endemic tetanus), the soil seeming peculiarly rich in the bacilli.

The European war has clearly demonstrated the tellurian origin of the disease, the soil harboring the bacillus. Battles in some regions proved prolific in cases of tetanus, whereas in others no cases developed even after shell wounds.

There were 65 cases of tetanus among the 26,600 wounded in hospitals at Cracow. This proportion of only 0.24 per cent, the writer ascribes to the fighting on wild, uncultivated land, in contrast to conditions at the



Cephalic tetanus, following disease of right upper molar. (*J. Mégevand.*)
(*Rev. méd. de la Suisse rom.*, Oct., 1913.)

western seat of war. *Arzt (Wiener klin. Woch.*, Dec. 24, 1914).

Of 66,110 wounded soldiers treated in the hospitals of Dvinsk during the first 11 months of the war, 95 (0.134 per cent.) suffered from tetanus. In other regions the disease was more common. Feinman (*Russky Vrach*, Sept. 26, 1915).

In almost all cases of tetanus there is traceable trauma, and many even doubt the possibility of the disease without a solution of continuity of tissue sufficient to permit entrance of the germ.

Idiopathic cases following exposure to cold seem, however, to occur. Probably such cases should be attributed to presence of the bacillus in the intestinal canal, or to some unsuspected avenue of infection, such as diseased teeth, microscopic abrasions, etc. The wounds most favoring tetanus are lacerated and contused wounds, especially where nerves are involved. Injuries of the hands or feet are especially susceptible. The disease, however, may also follow extraction of teeth, burns, frost-bite, insignificant scratches or injuries from splinters, needles, tacks, etc.

Vaccination has been regarded as an occasional cause of tetanus, but recent researches by J. Anderson, of the U. S. Public Health Service, have led to the conclusion that the disease was due to contamination of the vaccination wound from the exterior.

Comprehensive research showing:

1. That it is difficult, if not impossible, to produce tetanus in susceptible animals by vaccination with virus purposely containing large numbers of tetanus organisms.

2. Failure to demonstrate tetanus organisms in a large amount of vaccine virus specifically examined for that purpose.

3. That from 1904 to 1913, inclusive, over 31,000,000 doses of vaccine virus were used in the United States, yet information was obtained of only 41 authenticated cases of tetanus occurring subsequent to vaccination. Had the vaccine used during that time in the United States been at fault many more cases of tetanus should have followed vaccination.

4. That in view of the large number of vaccinations (about 585,000) done in the United States Army and Navy and the absence from them of a single case of tetanus following vaccination, the cases of tetanus following vaccination in the country at

large were not due to infection contained in the virus.

5. That the average period from vaccination to onset of symptoms of tetanus in 83 cases of tetanus following vaccination was 20.7 days, while the average mortality of 93 cases was 75.2 per cent.

Cases of tetanus occurring 15 or 20 days after vaccination probably acquire their infection about the tenth day or later after vaccination. J. F. Anderson (U. S. Public Health Reports; Reprint 289, July 16, 1915).

It may follow child-birth in women, although of late years this puerperal form has been much less common than before the days of asepsis.

In the last 50 years only 2 cases of puerperal tetanus have occurred in Edinburgh district. It does not differ from other forms, except in the site of infection. The incubation is generally given as from 7 to 10 days. The mortality rate in acute cases is at least 90 per cent., the majority of cases dying before the fifth day. Worrall (Austral. Med. Gaz., May 17, 1913).

A clean wound, of course, involves much less danger than a dirty one.

Surgical operations in almost any part of the body may be followed by tetanus. As first shown by R. Matas fecal contamination is important, any operation involving the intestine, its orifice, or the perianal structures affording an entry to the specific organism if it happens to be present, as is often the case in the intestine.

The injuries and surgical operations in regions exposed to fecal contamination are the most liable to tetanic infection, the anorectal region, perineum, female genitourinary tract, male genitals, especially scrotum, lower pelvic region, including buttocks, sacrococcygeal region, groins, thigh, knee, upper leg (on their posterior and inner surfaces especially): after operations on the intestines, ar-

tificial anus, etc. There may also occur unconscious transmission of fecal matter to distant parts of the body by the soiled fingers of the patient himself, or of his attendants.

In all the cases of postoperative tetanus occurring after operations in regions liable to fecal contact, the patients had eaten copiously of uncooked vegetables within 36 hours before the operation. Those most contaminated with tetanus germs and spores are celery, lettuce, chicory, water-cress, cabbage, radishes, turnips, carrots, tomatoes, and other green vegetables, berries, and fruits which are grown in contact with soil and are largely consumed raw. Five per cent. of all normal men harbor the tetanus bacillus or its spores in an active state in the intestinal canal; 20 per cent. among hostlers, stablemen, dairymen, drivers, etc. (Pizzini). R. Matas (*Monthly Cyclo. and Med. Bull.*, Dec., 1909).

The intestines of certain animals, particularly herbivora, seem to offer especially favorable conditions for the growth of the tetanus bacillus; such animals are "**tetanus carriers**." The presence of tetanus spores in soils, street dust, fresh vegetables, and on clothing and the skin is undoubtedly due to fecal contamination. Noble (*Jour. of Infect. Dis.*, Mar., 1915).

A large majority of the reported postoperative cases in the preaseptic and early aseptic era were connected with operations in the female pelvis. In view of various experimental and bacteriological data obtained, it seems possible that some human beings carry and excrete tetanus organisms for long periods, and are really **tetanus carriers**. Their greatest danger is to themselves, because after operative procedures which permit fecal contamination of the wound, tetanus may be inaugurated. This is particularly true of abdominal operations where the gut is bruised or roughly handled. K. Speed (*Surg., Gynec., and Obstet.*, Apr., 1916).

BACTERIOLOGY.—The tetanic bacillus growing under favorable conditions is a characteristically drumstick-shaped organism, with a considerable enlargement at one end in which a bright, round spore can be seen. The non-spore-bearing bacilli are long, slender, having rounded ends, are motile, and are numerous when temperature and other conditions are unfavorable. The organism will not grow in the presence of the smallest amount of oxygen. It stains readily by Gram's method, and with ordinary watery solutions of the aniline colors. It is very common in certain soils in thickly inhabited countries; in particular, soils which have been manured. It is also present in the atmosphere, especially a dust-laden atmosphere, and has been shown in the scrapings of the walls and floors of hospitals in which tetanic cases have been treated. It is always found in the pus or other discharge from tetanus-infected wounds, and is frequent in stools of tetanus cases.

The organism possesses exceptional powers of resistance, retaining its virulence for months in dried pus, and surviving antiseptics, heat, etc., which would prove quickly fatal to other pathogenic germs. The poisons generated by them have been isolated by Brieger from filtrates of several-weeks-old cultures in the shape of two basic substances: tetanin and tetanotoxin. Brieger and Fränkel have also isolated an intensely poisonous toxalbumin.

The phenomena of tetanus are readily produceable in lower animals by minute portions of these toxins introduced into the tissues.

The activity of the tetanus bacillus

seems enhanced when certain other bacteria—the *Bacillus aerogenes capsulatus* particularly—are present.

The *Bacillus aerogenes capsulatus* of Welch is frequently found in the feces of horses and in soil which seems most often to give rise to tetanus. Even ordinary street dirt and dust often contains it: 3 of 4 fatal cases of tetanus were also infected by this malignant organism. In 2 it was found in the heart's blood after death. The virulence of the tetanus bacillus itself can be greatly increased by the presence of other pathogenic bacteria. M. H. Gordon (Lancet, Oct. 31, 1914).

It is unnecessary to heat the suspected material to 80° C. to kill off other bacteria. Heating to 60° C. one hour is ample, while it does not modify the toxicity of the tetanus bacillus. Ninni (Annali d' Igiene, Nov., 1920).

PATHOLOGY.—The disease is purely toxic, without typical or constant morbid anatomical changes. There is apt to be a small, slightly suppurating wound, with some congestion of adjacent parts. The nerves in the vicinity may be inflamed, red, and swelled, but characteristic lesions in the nerves or nerve-centers are wanting, although in the brain and spinal cord minute hemorrhages, distention of capillaries, perivascular exudation, and pigmentary or other degenerative changes in nerve-cells have been described. Tetanotoxin gradually penetrates the axis-cylinders of nerves travelling centripetally.

Hypostatic congestion of the lungs is a frequent post-mortem finding, and rupture of muscle-fibers from violent contraction has been seen.

PROGNOSIS.—The prognosis is grave, about 80 per cent. of traumatic and 50 per cent. of the so-called idiopathic cases proving fatal.

On the western battle front the mortality in 351 cases of tetanus was 70 per cent., at Hamburg only 49 per cent. This is because the latter cases were those with a long incubation period, while the cases observed at the front were those in which the attacks came on soon after the wounds. Kummell (Beitr. z. klin. Chir., xcvi, 421, 1915).

Puerperal tetanus is rarely recovered from, and tetanus neonatorum is almost always fatal.

The least dangerous cases are those in which the spasm remains localized in the jaw- and neck- muscles. The prognosis is also better when the period of incubation is prolonged.

In a series of cases the prognostic value of the duration of incubation was clear. In all cases in which this exceeded 10 days, recovery followed. The cardiorenal apparatus is a decisive factor. A pulse rate low in proportion to the temperature and a pronounced diminution in the urinary output are bad prognostic signs; likewise, profuse sweating, especially of the face and head, at the onset of and during the paroxysms. P. R. Joly (Bull. de l'Acad. de Méd., Jan. 26, 1915).

The afebrile cases offer a more hopeful outlook than those with fever. When paroxysms are frequent, severe, and involve all muscles of the trunk, recovery is scarcely to be hoped for.

In tetanus pulmonary and cardiac complications may cause death. Cases with spasms of the diaphragm and glottis have an unfavorable prognosis, because these manifestations cannot be reached by treatment; epigastric pain points to forthcoming spasms of the diaphragm. Rarely tetany is mistaken for tetanus. Next to death from spasm of the glottis, confluent lobular pneumonia is the chief cause of death. It may occur in time to be an integral part of the

disease. Pribram (Berl. klin. Woch., Aug. 30, 1915).

In a personal case tetanus recurred 55 days after the close of a first attack of cephalic tetanus. It assumed the paralytic type, without contraction, and there was a confusional state suggesting cerebral tetanus. No serotherapy had been given after the subsidence of the first attack. P. Beaussart (Bull. de la Soc. Med. des Hôp., Apr. 22, 1921).

TREATMENT.—Wounds in which contamination is probable should be carefully cleansed and aseptitized, opening freely under anesthesia if required until all tissues are exposed. All detritus, dead tissues, etc., should be removed and a 5 per cent. solution of **hydrogen peroxide** injected into every recess of the wound, the tetanus bacillus succumbing to the oxygen.

The wounded develop tetanus because tetanus bacilli are allowed to proliferate. If we clear out the wound with **hydrogen dioxide** and **potassium permanganate** there will be no tetanus. Koch (Therap. Monats., Mar., 1915).

Experiments on guinea-pigs, in which after tetanus inoculation **oxygen** was injected through a needle into the inoculated area. Most of the pigs so treated recovered without any symptoms, while the controls all died. The method is suggested as a possible means in the treatment of human cases. H. O. Howitt and D. H. Jones (Lancet, Apr. 10, 1915).

For the same reason, **free drainage** should be insured for deep wounds and crust formation avoided. **Dried antitetanic serum** applied copiously to the exposed surfaces is helpful. The surrounding area should also be aseptitized, preferably with **tincture of iodine** after thorough cleansing. No strong antiseptic should be used in the wound, as it would close

the lymph-spaces. **Chlorinated lime** seems worthy of trial.

Tetanus is rare after rifle wounds, but common after shrapnel wounds. Infection by contact is possible; tetanus patients should, therefore, be isolated. They should not lie directly on straw. Deep wounds are to be opened, disinfected, and given free drainage. The wounded surface should be kept moist and free from drying scabs. **Phenol** is the time-honored local anesthetic. Carrel's **chlorinated lime** and **boric acid** dressing seems better, impermeable crusts being less likely to form. **Iodine** as a disinfectant is still disputed, but it is non-toxic, prevents the growth of ordinary pyogenic organisms and produces a prolonged hyperemia.

The treatment of the wound is not so important as immediate **antitoxin** injection. Aschoff and Robertson recommend absorbent **cotton soaked in antitoxin** and dried. The cotton becomes moistened by secretions and the antitoxin set free. McGlannan (N. Y. Med. Jour., Nov. 27, 1915).

The results thus far obtained by **antitoxin** treatment have not been distinctly favorable, probably because tetanus is unsuspected until too late for results from specific treatment.

In 1300 wound cases, prompt use of 20 units of antitoxin prevented tetanus in all but 1 case. Although during the war **curare** had been tried with negative results, the writer attributes recovery to its use in a fully developed case of tetanus, first seen 10 days after receipt of a severe lacerated head wound. **Chloral** was then exhibited, and incidentally a small dose of curare, repeated until 6 mgm. ($\frac{1}{10}$ grain) injected. This produced asphyxia, and the dose was limited to 5 mgm. ($\frac{1}{2}$ grain) daily with 45 grains (3.0 Gm.) of chloral. The spasms ceased for some hours daily, to reappear sooner or later with varying severity. The patient recovered after taking 63 mgm. (1 grain) of curare in 14 days. Schoen-

bauer (Wiener klin. Woch. Feb. 17, 1921).

A favorable effect is, however, often noted, especially when the premonitory symptoms are detected early. Antitoxin should always be used, however, as it is probably the best single remedy now at hand.

The first thing done in tetanus should be an **intrathecal injection of tetanus antitoxin**. The fluid withdrawn will, as a rule, not be more than 20 c.c. If the serum used be of the ordinary strength of 150 units in 1 c.c., the patient will receive a dose of some 3000 in 20 c.c. If the serum be of higher potency—say, 800 units to the c.c.—the patient will have received 16,000 units. For intrathecal injections this high potency serum, if procurable, should by all means be used. At the same time, 5 to 10,000 units should be injected intramuscularly and 3 to 5000 may also be given subcutaneously. The intrathecal injections may be repeated daily for three to five days; the intramuscular and subcutaneous may be continued daily or oftener, according to the symptoms. When there are distinct signs of abatement, the dose may be gradually reduced, the intervals lengthened, and the serum given only subcutaneously. There is no convincing evidence that phenol treatment has any curative effect. The cessation of spasm which follows a magnesium sulphate injection is purchased at the cost of distinct risks. Brit. War Office Committee on Tetanus (Brit. Med. Jour., Nov. 11, 1916).

The writers place the methods of administration of **tetanus antitoxin** in the following order as to efficiency: intramuscular, subcutaneous, intrathecal, and intravenous. The latter should not be used, entailing a risk of anaphylactic shock and being of little therapeutic value. By the combined subcutaneous and intramuscular routes the daily dosage for the first few days should not fall below 10,000 units. Leishman and Smallman (Lancet, Jan. 27, 1917).

The focus of tetanic infection must be widely opened up, curetted and disinfected with oxidizing agents. Crystals of **sodium persulphate** scattered in the wound are more useful than hydrogen peroxide solutions, acting longer. When the first symptoms of tetanus appear, the authors give 30 c.c. of the antiserum daily for three days and when not quite certain that all the tetanus bacilli have been eliminated from the wound, continue the injections further. Sodium persulphate keeps well in sealed tubes. For use, 5 Gm. (75 grains) are dissolved in 100 c.c. (3½ ounces) of cold, sterilized, distilled water, and 20 c.c. (5 drams) of the solution is injected into an elbow vein morning and night for three or more days. In about half the cases brief vomiting follows; this may return a few hours later, but is often absent after the second or third injection. Sometimes **chloral hydrate** or another sedative is added. In a case of respiratory spasm, prompt and complete success followed **blocking** of the **phrenic nerve** by injection of 10 c.c. (2½ drams) of a 1 or 2 per cent. solution of **procaine** with a little **adrenalin**. Bérard and Lumière (Presse méd., Sept. 12, 1918).

The alkali **persulphates** are highly destructive to the tetanic poisons. A 1.5 per cent. solution of **procaine** with addition of a drop of 1:1000 **adrenalin** solution, injected into the brachial plexus for the upper limb, at the point of emergence of the sciatic for the lower limb, and about the nerve-trunks supplying the groups of contracted muscles, gave very gratifying results in all instances. For prophylactic purposes the writer uses an **iodized tetanus toxin**. Bazy (Lancet, Oct. 19, 1918).

The former belief that amputation of the wounded extremity would forestall the disease has not been sustained. Many believe also that too active surgical measures in the wound promote its development.

Removal of the seat of infection by amputation is useless. Of 5 cases thus treated even before the disease developed, 4 died. Hochhaus (Münch. med. Woch., xlv, 2253, 1914).

Fulminating case of tetanus which developed the twenty-first day after the shell wound. The man was recovering from his injury when a correcting operation was undertaken, opening up a fistula; the tetanus developed four days thereafter. The germs must have been already in the wound but quiescent until roused. When he finds the knee-jerk in a wounded limb exaggerated and growing constantly more pronounced, he accepts this as a sign that tetanus is already installed, although there may be no other sign or symptoms of it. He administers **magnesium sulphate** at once in amounts sufficient to reduce the reflexes to normal. Heile (Berl. klin. Woch., Feb. 15, 1915).

Baccelli's treatment by means of a 2 or 3 per cent. solution of **phenol** (**carbolic acid**) has also given good results, i.e., 17.36 per cent. in Italy, where tetanus is quite common. That as low a mortality has not been obtained elsewhere from this method is attributed to the fact that tetanus in Italy is often not as severe as in other countries. The solution may be used in from 1- to 2- dram (4 to 8 Gm.) doses hypodermically every two or three hours. **Antitoxin** and **phenol** together are especially useful.

The writer is more and more satisfied with his method of treatment, which has also given good results in other hands. In 190 cases treated by Italian and other physicians the total mortality, according to Imperiali, was 17.36 per cent. Among 94 severe cases there were only 2 deaths, and among 38 of marked severity, excluding 11 in which the dose was much too small, 5 deaths. The amount of **phenol** injected often exceeded 0.1 to 0.15 Gm. ($1\frac{1}{2}$ to $2\frac{1}{2}$

grains). He ordinarily used a 2 to 3 per cent. watery solution, beginning with 0.3 to 0.5 Gm. (5 to 8 grains) of the acid daily to test the tolerance of the patient, and then rapidly increasing to 1.0 to 1.5 (15 to 23 grains) in several injections. The massive doses are only to be employed with great care and in serious cases. G. Baccelli (Berl. klin. Woch., nu. 23, 1911).

Phenol injections used in 5 consecutive cases, all recovering; 2 other cases treated with antitoxin died; 10 minims (0.6 c.c.) of 10 per cent. solution of pure phenol in sterile water, diluted to 30 or 40 minims (1.8 to 2.5 c.c.), injected deep into the muscles, at first every three hours, later at longer intervals as improvement appeared. The urine should be watched for smokiness. Kintzing (N. Y. Med. Jour., Dec. 23, 1911).

Supplementary to the usual **anti-tetanus serum** treatment, the writers recommend the copious use of **phenol**, either by the Baccelli subcutaneous method or by giving **salol** orally, or both. Arnd and Krumbein (Correspondenzbl. f. schweizer Aerzte, Nov. 28, 1914).

Series of 22 tetanus cases in which **Baccelli's method** was applied: Twice daily an injection of 40 to 50 c.c. ($1\frac{1}{2}$ to $1\frac{3}{4}$ ounces) of a 2 per cent. phenol solution was given subcutaneously, in the vicinity of the wound whenever possible, otherwise in the thigh or abdomen. The patients thus each received 1.6 to 2 Gm. (25 to 30 grains) of phenol a day, and in 2 the injections were continued for nearly a month. There was local erythema in 2 cases and an aseptic fluid accumulation where many injections had been given in the thigh. No signs of general intoxication, such as dark-colored urine, were ever noticed. Paul Sainton (Bull. de l'Acad. de Méd., Dec. 1, 1914).

Of 22 cases of tetanus treated with **chloral hydrate** in doses of 20 to 28 Gm. (5 to 7 drams) per diem and **morphine** in doses of 0.02 to 0.06 Gm.

(1 grain), only 6 ended favorably, while among 13 cases in which 0.75 Gm. (12 grains) of **phenol** was injected daily round the wound, 4 were cured. Nigay (*Presse méd.*, Jan. 21, 1915).

Captain Everidge reported a case of tetanus complicated with mental symptoms (*Brit. Med. Jour.*, Mar. 25th). The writer had a very similar case in a negro. Just enough **chloral hydrate** was given to keep him constantly under its influence. The total amount given was considerable. As he was recovering from the tetanus hallucinations were very marked. There was no rise of temperature. He suspected the **chloral** and discontinued it, and the symptoms gradually passed off. Recovery was complete a week later. In Everidge's case the chloral dosage was large, and in view of the writer's own case the mental symptoms might be more rightly attributed to this than to the **phenic acid**. W. F. Law (*Brit. Med. Jour.*, Apr. 22, 1916).

Precautionary measures are always in order after **tetanus antitoxin** to avoid anaphylaxis. Should the case, after recovery, contract diphtheria, an injury suggesting the possibility of tetanus, or be exposed to typhoid fever, etc., and receive prophylactic injections of their specific sera, the possibility of anaphylaxis is to be thought of. Indeed, it occasionally attends the use of prophylactic injections when these are first used.

Case of a wounded man of 30 who received an injection of 10 c.c. (2½ drams) of **antitetanic serum**, and 4 years later was given another injection after being again wounded. Two series of untoward results followed this second injection; first, a localized pseudophlegmonous edema, then, 9 days after the injection, very severe general phenomena for 3 days, viz., sudden attacks of cardiac weakness, vomiting, generalized urticaria, extreme asthenia, scanty urine

and albuminuria. These manifestations correspond closely to experimental anaphylactic shock. The patient subsequently showed paralysis of the latissimus dorsi with muscular atrophy and reaction of degeneration. P. Thaon (*La méd. mod.*, Nov. 26, 1910).

Two cases of tetanus developing after a shell injury of the upper arm. One man was given 200 antitetanus serum units, both intravenous and intraspinal, repeated the next day and followed daily with 100 units intravenously after the arm had been amputated. He was progressing favorably until the fourteenth injection, followed by severe anaphylaxis. Under stimulants in an hour he recuperated. The next day he developed an exanthem. The other case showed twitching in the arm and face, but as this subsided after intravenous injection of 300 units, the assumption of tetanus seemed to have been erroneous. Thirteen days later the symptoms returned in a severe form. Injection of 300 units was followed in a few minutes by cyanosis, a chill and temperature of 40.9° C. (105.3° F.), but the pulse kept good. After this there were no symptoms of tetanus. Three days later, the seventeenth day after the first injection, 100 units were injected intravenously again, severe anaphylactic shock ensuing, with total unconsciousness for half an hour and marbling of the body, the pulse scarcely perceptible, and finally a chill and temperature of 40.1° C. (104.2° F.). By the next day the pulse and breathing were normal again. These cases suggest that the tenth day is the danger line. Simon (*Jour. Amer. Med. Assoc.*, from *Münch. med. Woch.*, Nov. 10, 1914).

Magnesium sulphate, recommended by Meltzer, Auer, Hanbold, and others, when given in doses insufficient to morbidly affect the respiratory center, abolishes or, at least, noticeably inhibits the spasms, and thus tides the patient over until anti-

bodies are formed to counteract the tetanotoxin in the nerves. It may be administered subcutaneously or intraspinally.

The **magnesium sulphate** treatment, in about 50 cases, has lowered the mortality to 35 per cent. Individual susceptibility to magnesium sulphate varies, and the dose must be regulated by actual trial in each case. The subcutaneous method, available to the general practitioner, requires a most careful supervision of the patient. A slight tendency to paralysis of the respiration must be constantly watched for as the initial sign of possible serious trouble. To antagonize the excessive action of the magnesium salt, 1 dram (4 c.c.) of a 5 per cent. solution of **calcium chloride** may be injected repeatedly into the muscles, as required. The most important measure, however, is **artificial respiration**, which may prove sufficient alone, particularly if $\frac{1}{16}$ grain (0.001 Gm.) of **physostigmine salicylate** has previously been injected. Intratracheal insufflation is advantageous; either **oxygen** may be run in from a tank or air pumped in with bellows. Intraspinial injection of the salt is a better procedure than subcutaneous use, but is difficult to apply except in hospitals, as a single physician cannot carry it through. Weintraub and Unger (Berl. klin. Woch., Oct. 19, 1914).

The chief object of **magnesium sulphate** is to gain time until the body forms antibodies. Meltzer and Auer found that the maximum dose was 1.5 Gm. (23 grains) to 1 kg. (2 $\frac{1}{2}$ pounds) of body weight. Giving it in fractional doses throughout the 24 hours this amount can be given on from 6 to 18 successive days without doing any harm. The severer the case the larger initial dose is given, and it may be well to give it intravenously for quicker action. It is not necessary to give the full dose to produce complete relaxation of the muscles; it is sufficient to depress the centers so that the convulsions

stop, even though some stiffness persists. In giving such a dose there is practically no danger of producing paralysis of respiration, hyperexcitability of the nerve-centers being overcome sooner than their capacity for reaction to physiological stimuli. The sulphate is excreted very rapidly, most rapidly after intravenous injection, next after intramuscular and slowest after intraspinal injection.

The writer recommends the subcutaneous injection of 10 c.c. (2 $\frac{1}{2}$ drams) **antitoxin** on the first, fifth, eighth, and twelfth days after an injury. As soon as any signs of tetanus develop a subcutaneous injection of 25 per cent. **magnesium sulphate** is given, the amount depending on the weight of the patient. This generally has to be repeated four times the first twenty-four hours. Careful watch of the patient must be kept so that the additional doses may be given at the proper time. If the subcutaneous administration is not effective, then it should be given intramuscularly. Straub gives it intravenously, but this involves some danger to the heart. T. Kocher (Correspondenzbl. f. schweizer Aerzte, xlv, 1249, 1915).

As to general treatment, the case should be placed in a darkened quiet room. No one but the doctor and nurse should have access, and every possible source of irritation causing spasm should be rigorously excluded. The **diet** should be **liquid**, nourishment by enema being employed if the trismus is marked. Of remedies for combating the spasm **chloroform** is most quickly efficacious, but the relief obtained is liable to be temporary only, and secondary hepatic lesions may be caused. **Nitrite of amyl** will occasionally abort a paroxysm. Other antispasmodics are **chloral hydrate**, **chloretone**, **Calabar bean**, the **bromides**, and **curare**. Continuous **warm baths** are helpful in most instances.

Ice to the spine is also recommended, as is **bleeding**.

McClintock and Hutchings found **chloretone** the best substance to relax the muscles in tetanus. Subsequently Hutchings published 6 cases treated with chloretone, with 4 recoveries. Chloretone has the advantage over the intraspinal injection of magnesium sulphate in its greater safety. Hobbs and Sheaf (Brit. Med. Jour., Nov. 5, 1910).

Two cases of tetanus in which the writer employed **atropine**. A colored boy, 14 years old, who under usual measures was given by the mouth $\frac{1}{8}$ grain (0.008 Gm.) of atropine every two hours for 3 doses and then every four hours. From the first dose the spasms markedly decreased and the patient obtained good rest at night. In about four weeks he was up and about. Small doses of **calomel** and **sodium sulphate** were given to keep the bowels open, and the wound was dressed with **hot turpentine**. A second was treated similarly, but with smaller doses, and by the beginning of the fourth week all symptoms had disappeared. The writer has seen many cases of tetanus, and was surprised at the effect of the treatment. A Government veterinary surgeon told him that he employed large doses of **belladonna** with small doses of **morphine** in tetanus in animals, and that a fatal result rarely occurred. R. F. Secoresto (Editorial, Lancet, May 21, 1910).

Special care as to cardi-renal measures is necessary, drugs such as **digitalis**, **strophanthus**, **camphorated oil**, **hexamethylenamine**, **squill**, **lactose**, **diuretic infusions**, and **Vichy-water** being recommended. To make up for respiratory inadequacy **oxygen inhalations** were given every hour or even every quarter-hour. **Venesection**, in 1 case, seemed to diminish convulsive attacks. Combined use of **morphine**, **camphorated oil**, **ether**, and **oxygen**, is recommended in allaying the convulsions. Joly (Bull. de l'Acad. de Méd., Jan. 26, 1915).

Various combinations of the most effective agents have been used, apparently with benefit.

The writer uses a combination of **antitetanus serum**, subcutaneous injection of 5 c.c. ($1\frac{1}{4}$ drams) of a 2 per cent. solution of **phenol**, plus local **cauterization** of the wound with **concentrated phenol**. This does not produce an eschar at once; so it burrows deep and effectually sterilizes. In 4 cases of tetanus after shrapnel wounds this method was successful. The writer administered the phenol injections once or twice a day at first, increasing to 5 or 6 a day. Voelcker (Münch. med. Woch., Oct. 27, 1914).

Six out of 8 cases of tetanus ended favorably under intravenous use of both **antitetanic serum** and **chloral hydrate**. The serum injections were given daily, beginning with a massive amount, 50 c.c. ($12\frac{1}{2}$ drams), and gradually diminished to 10 c.c. ($2\frac{1}{2}$ drams). Where the symptoms returned after a period of quiet, anaphylactic manifestations upon resumption of the injections were avoided by the previous administration (during the quiet period) of 10 c.c. ($2\frac{1}{2}$ drams) of the serum by rectum. The total amount of serum used ranged between 100 and 350 c.c. ($3\frac{1}{2}$ to 12 ounces). Chloral hydrate was used in a 5 per cent. solution, of which 60 c.c. (2 ounces) were given at a dose; in some cases 3 such doses were administered in a day. The effect of each dose was quiet sleep lasting three hours, after which a marked reduction in the convulsions persisted. Barnsby and R. Mercier (Bull. de l'Acad. de Méd., Mar. 23, 1915).

Saline solution bids fair to occupy an important position in the treatment of tetanus. Not only does it tend to counteract thirst while promoting osmosis, but it may be given with other useful agents—**ether**, **glucose**, **paraldehyde**, etc.

Being unable to obtain antitetanus serum in an extremely serious case, the writer treated the patient, a mulatto of 25, by cauterizing the wound, bleeding (500 c.c.), infusing a similar amount of **saline solution**, and then allowing all the cerebrospinal fluid that dripped slowly from a lumbar puncture to escape. He then washed out the cerebrospinal canal with saline solution containing 0.3 per cent. **sugar**, and left 2 syringefuls in the canal. These procedures were repeated the next day, giving an hour each time to them, washing out the canal with a liter (quart) of the saline, a drop at a time. The reaction, severe the first day, was much milder the second, and the patient afterward dropped to sleep and began to mend, and the procedures were repeated during the first five days, using smaller amounts, and the man left the hospital cured, the twelfth day. Kras (Wiener klin. Woch., Jan. 11, 1912).

Case in which spasms were controlled, sleep procured and feeding with milk rendered possible by repeated intravenous infusion of 15 to 30 c.c. ($\frac{1}{2}$ to 1 ounce) each of **ether** and **paraldehyde in normal saline solution**, producing prompt hypnosis, followed by relative muscular relaxation for several hours. Atkey (Lancet, Jan. 18, 1913).

Case in which the disease began insidiously. Treatment was intensive—serum, magnesium and morphine. The patient, however, seemed doomed; so that a new resource was sought. Fifteen cm. ($\frac{1}{2}$ ounce) of **ether** were given in 750 cm. ($1\frac{1}{2}$ pints) of **saline infusion**, and the case at once began to improve, the treatment being continued until recovery. Hercher (Münch. med. Woch., Aug. 17, 1915).

Attempts to destroy the tetanus germs with the **ultraviolet rays** have been made with apparent success.

The radiation of jagged wounds with **ultraviolet rays** will kill tetanus bacilli and the bacilli of malignant

edema at the site of infection. This supplements surgical cleansing. Kromayer's lamp and the artificial high solar light may be used to generate the rays. Jacobsthal and Tamm (Münch. med. Woch., lxi, 2324, 1914).

Ultraviolet rays used in 4 cases and the men recovered. The incubation period had ranged from nine to seventeen days. Jesionek (Münch. med. Woch., Mar. 2, 1915).

Bilateral phrenicotomy has been resorted to to prevent death through spasm of the diaphragm.

Animal experiments having shown that **phrenicotomy** paralyzed the diaphragm without serious consequences to the victim, the intervention was tested on an 8-year-old boy with tetanus. The symptoms included a severe spasm of the diaphragm. In a general spasm the thorax was suddenly fixed in the maximal inspiratory position, while both the throat and abdominal muscles were rigid. The face cyanosed. Consciousness was finally lost and three or four minutes expired before the seizure passed over. The writer now divided both phrenics behind the sternomastoid muscles. The patient then had numerous convulsions without dyspnea. Attacks of the latter returned, however, and were met by **artificial respiration** and inhalations of **oxygen** under pressure. As the patient, on account of esophageal spasms, was no longer able to take nourishment gastrostomy was performed. He made a slow recovery. His general health did not suffer as a consequence. The only drug received during the tetanus was **chloral**. Jehn (Münch. med. Woch., Oct. 6, 1914).

PROPHYLAXIS.—While the remedial value of **antitetanic serum**, except perhaps in very large doses introduced by every avenue available, spinal, cutaneous, etc., has not been demonstrated during the European war, its merits as a prophylactic agent have clearly asserted them-

selves. From 500 to 1000 U. S. A. units have been found to suffice in most instances, while in severe wounds the repetition of the dose once or twice at intervals of a week is indicated. As emphasized by MacConkey, the occasional cases in which antitoxin appears to have no preventive action may often be traced to reaction of a quiescent focus or to too early or too energetic active or passive movements. When operation is proposed in wounded men who may have been infected with tetanus bacillus it is imperative to bear in mind that there may be toxin circulating in the body. A large prophylactic injection is consequently necessary, so given as to insure absence of free toxin in the blood at the time of the operation and for some time after. Subcutaneous injections, except as supplementary agents, are out of the question here because of the slow rate of absorption. If the injection be given intramuscularly, then the operation should not take place for several hours. An intravenous injection permits of the operation being performed at once.

The reliability of serum in preventing tetanus is not absolute. Early tetanus after serum injection is mainly due to imperfect sterilization of recent wounds and should be largely preventable. Late postseric tetanus may be prevented in over one-half the cases by injecting serum before all secondary operations. Serum treatment exerts a notable effect on the course of postseric tetanus. Lumière (Ann. de l'Inst. Pasteur, Jan., 1917).

Highly concentrated serum in doses sufficient to maintain protection, such as 3 c.c., may be repeated weekly as long as seems advisable without fear of anaphylaxis. Editorial (Lancet, Jan. 20, 1917).

Report of 3 cases of delayed onset of tetanus following gunshot wounds of bone. The periods of incubation were 86, 106 and 146 days, respectively. M. Foster (Brit. Med. Jour., Feb. 10, 1917).

Tetanus of the extremities results from local toxic impregnation through traumatism. It generally appears late, being due usually to an attenuated tetanic infection. While a few cases had been recorded before the advent of serum treatment, the number of instances has increased enormously since then, so that localized tetanus may be considered essentially a result of preventive serum therapy. E. Chauvin (Rev. de méd., Mar.-Apr., 1918).

A definite part seems to be played by *B. welchii* in the causation of tetanus. Its capacity for harm can be almost eliminated by the use of *B. welchii* antitoxin. The *Vibrion septique* may also play a part. W. J. Tulloch (Brit. Med. Jour., June 1, 1918).

During the early part of the war there were 24 cases of tetanus among each 1000 of English wounded, and still more among the French. Injection of antitoxin was first made compulsory in all cases of infected wounds, and later in all wounds. Thereafter less than 1 in 1000 developed tetanus, and these rare cases usually had received no antitoxin. The serum, in the developed cases in France, was generally given subcutaneously or intravenously. The British advocated the intraspinal method. W. H. Park (Med. Assoc. of N. Y.; N. Y. Med. Jour., Nov. 2, 1918).

The writer recommends the inhalation of ether, though not enough to put the patient to sleep. The patient holds the mask himself and the ether is given, 60 c.c. (2 ounces) morning and night, by the drop or teaspoonful. Seven patients recovered, but the eighth died the tenth day. Audrain (Prog. méd., Sept. 20, 1919).

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THEOBROMINE. See DIURETIN.

THEOCINE.—Theocine is the trade name for synthetically prepared theophylline, the alkaloid of tea-leaves. It is closely related to caffeine and to theobromine, the double salt of which, theobromine sodium salicylate, known as diuretin, has been much employed as a diuretic. While the average urinary increase caused by the latter is three-eighths more, theocine causes 6.3 as much. Theocine occurs as a white, odorless, crystalline powder having a bitter taste, and soluble in 180 parts of water at ordinary temperature, and in 85 parts at 98.6° F. (37° C.), sparingly soluble in alcohol and insoluble in ether. It forms easily soluble compounds with ammonium and potassium, a less soluble one with sodium, but a freely soluble double salt with sodium acetate (theocine, or theophylline, sodio-acetate).

The usual dose of theocine or the sodio-acetate is from 3 to 5 grains (0.2 to 0.35 Gm.), given three times daily, in warm tea. It may also be given in suppository or enema, to avoid direct irritation of the stomach; its hypodermic administration is not advised because so often inefficient, and sloughing of the skin has followed its use by hypodermoclysis. It should never be given on an empty stomach.

PHYSIOLOGICAL ACTION.—Theocine has a diuretic action similar to that of caffeine and theobromine, which is believed to be due to a direct effect upon the secreting cells of the kidney. Not only is the water of the urine increased, but also the salts (especially sodium chloride). When theocine acts at all it acts promptly (in two or three hours), and in small doses, and its effects are not prolonged. The first dose is generally the most efficient in producing marked diuresis.

On the gastrointestinal mucous membrane theocine acts as a local irritant, as is shown by the frequency with which nausea and vomiting may occur, by the occasional diarrhea (sometimes mucous in character), and by hemorrhagic erosions found *post mortem*.

Effects on the nervous system are not usually observed until the third or fourth

day, when irritation of the cortical motor centers is apparent, and may be severe enough to cause convulsions (Stross, Schlesinger, Allard, and Hundt), or even death (Hundt 2 cases, Alkan, and Arnheim). Like all caffeine-like drugs, it may cause wakefulness and excitement (Minkowski, Stross, Hundt) even in moderately small doses, in which case the evening dose should be combined with an hypnotic or the last dose given not later than noon (Stross). Belladonna will relieve the disagreeable effects of theocine without lessening its diuretic action.

Cardiac action and blood-pressure are apparently uninfluenced by theocine.

THERAPEUTIC USES.—Theocine is employed in the treatment of **cardiac affections, nephritis, dropsy**, etc., where a rapid diuretic effect is desired. On account of its toxic properties, theocine should be administered only in cases where life is in immediate danger or when other diuretics have failed. The drug acts best when there are large serous accumulations, particularly in cardiac or cardiorenal disease, in which there is still left considerable renal secreting tissue. In **chronic nephritis** diuresis may be expected if a goodly portion of the renal epithelium is still functionally active; in advanced chronic interstitial nephritis little effect should be looked for, but in **acute nephritis** very profuse diuresis may be obtained and large dropsical accumulations absorbed.

In ascites due to hepatic cirrhosis and chronic peritonitis, the drug often fails; in alcoholic cirrhosis calomel is the supreme diuretic (Stross). W.

THERMIC FEVER. See HEAT EXHAUSTION AND THERMIC FEVER.

THIOLCOL.—Thiolcol is potassium-guaiaicol sulphonate. It occurs as a white, crystalline, odorless, permanent powder, having a faintly bitter saline, but not unpleasant taste. It is neutral in reaction, or slightly alkaline, readily soluble in water, dissolves in alcoholic solutions, but is insoluble in absolute alcohol, and in ether or fats. It is incompatible with silver salts, ferric compounds, and perman-

ganate solution. It contains about 60 per cent. of guaiacol.

PREPARATIONS AND DOSES.—

Thiocol may be prescribed either in plain powder in cachet, capsule, or tablet, or in aqueous, alcoholic, or syrupy solutions; its faintly bitter, but not disagreeable taste is covered by orange syrup or syrup of cinnamon. The adult daily dose is from 45 to 80 grains (3 to 5.3 Gm.) per diem, taken in three equal portions, after meals. As much as 4 drams (15 Gm.) have been given daily with benefit.

PHYSIOLOGICAL ACTION.—Thiocol is non-irritating to the mucous membranes of the digestive tract, is readily absorbed, promotes the appetite, and improves nutrition. It apparently has no deleterious action on the blood; the erythrocytes, albuminous constituents, and the hemoglobin are increased. A striking increase of weight, during its administration, has been observed. Thiocol is excreted by the kidneys, the total amount of the sulphur being found in the urine as sulphate, with a small proportion of guaiacol sulphonate. Thiocol has been taken uninterruptedly for months without any unpleasant effects.

THERAPEUTIC USES.—Thiocol is employed in **phthisis, chronic coughs and catarrhs, pneumonia, acute and chronic bronchitis, whooping-cough, pulmonary emphysema**, etc. In these diseases thiocol is said to lessen the expectoration, control night-sweats, and improve the nutrition of the patient. Therapeutically, thiocol possesses all the good properties of creosote, but, for the most part, without its evil ones (Cole).

In **dyspepsia, gastroenteritis, diarrhea, scrofula, rachitis, anemia, cutaneous and glandular tuberculosis**, thiocol exhibits strong bactericidal and stimulating effects.

THIOSINAMINE.—Thiosinamine, allyl sulphocarbamide, or allyl thiourea [$\text{H}_2\text{N} \cdot \text{CS} \cdot \text{NHCH}_2 \cdot \text{CH} : \text{CH}_2$], discovered in 1833 by the French chemists Dumas and Pelouze, was introduced into medicine by Hebra, who, in 1892, advised its use to avoid disfiguring cicatrices in lupus. The drug is prepared by warming together volatile oil of mustard (mainly allyl thiocyanate) and an alcoholic solu-

tion of ammonia, and recrystalling from alcohol the resulting crystalline condensation product. Thiosinamine appears as shining, colorless, prismatic crystals with a slight odor of garlic and a bitter taste. It is decomposed when dissolved in water (glycerin to a slight extent hinders this decomposition), but can be dissolved without change in 3 parts of alcohol or in ether. The internal dose of thiosinamine in capsule or tablet triturate is $\frac{1}{2}$ to $1\frac{1}{2}$ grains (0.03 to 0.1 Gm.); the subcutaneous dose, 1 to 5 grains (0.06 to 0.2 Gm.) in 15 per cent. alcoholic or 10 per cent. glycerinated water (1:5) solution.

Fibrolysin, or solution of thiosinamine sodium salicylate, introduced by Merck in 1904, is a sterilized solution, supplied in sealed vials, containing 15 per cent. of a double salt of thiosinamine and sodium salicylate (2 molecules of thiosinamine to 1 of the salicylate), made by mixing the two compounds in solution. The solution is odorless, and it does not keep well in the air. Each sealed vial contains an amount of solution corresponding to 0.2 Gm. (3 grains) of thiosinamine, this amount measuring 2.3 c.c. (37 minims). *Fibrolysin* is considered superior to thiosinamine in being absorbed more rapidly and producing less local irritation on account of its solubility and watery vehicle. Dose, the contents of 1 vial by subcutaneous, intramuscular, or intravenous injection, daily or on every second or third day.

PHYSIOLOGICAL ACTION.—Thiosinamine and fibrolysin have been widely credited with a dissolving action on fibrous tissue, especially that recently formed. It has been supposed that, through their influence, the recent connective-tissue fibers are invaded by leucocytes and digested away. According to the experiments of Gervino (1908) in rabbits and dogs, hypodermic injection of a 15 per cent. alcoholic solution of thiosinamine markedly lessens the formation of cicatricial bands round a foreign body introduced into the peritoneal cavity, and hinders the reformation of adhesions previously broken down. Other observers, however, after performing similar experiments, have denied the production of such effects. According to the work of Char-

teris (1909), thiosinamine exerts but little effect on the number of white blood-cells, and has no chemiotactic influence on these cells, failing to attract leucocytes to points where it is introduced. Tyrode (1909) found that in large doses, given to animals, thiosinamine causes a rapid loss of weight even before appetite is reduced, with coincident marked increase of urea excretion, suggesting an augmented catabolism of proteins. A generalized fatty degeneration of parenchymatous organs (especially the heart and kidneys) was also produced in less than a week, but no special action on the normal connective tissues was observed.

Scars locally treated with thiosinamine become hyperemic for a brief period, then exhibit pronounced desquamation and gradually become pale, translucent, soft, and pliable. This change has been ascribed to serous exudation in the inter-fibrous spaces, is produced within a few hours, and persists a few days. It is accompanied by dilatation of the lymphatic channels, with a slight proliferation and desquamation of the endothelium (Brandenburg). Starkenstein, from experimental work, has concluded that thiosinamine acts, not in the manner hitherto believed, but by favoring hydrolysis of the slightly soluble and slightly digestible collagen of the connective tissues, with resulting formation of more soluble and more easily absorbable isomeric substances of the gelatin type.

UNTOWARD EFFECTS AND POISONING.—Patients, after receiving thiosinamine or fibrolysin, frequently experience an unpleasant bitter taste in the mouth, with garlicky, sulphur, or mustard-like eructations. Diuresis is often noticed. At times headache and lassitude follow the injection, persisting one day. After large doses in susceptible individuals there may occasionally occur, in addition to headache, vomiting, dizziness, inco-ordination, diarrhea, and general weakness. Instances of thiosinamine intoxication occur, as a rule, after several previous injections have been received without especial ill effect. Severe symptoms then suddenly develop in a few hours after the next injection, *e.g.*, violent vomiting, nausea, rigors, and marked weakness, with a

rapid pulse and fever persisting for a day or two. Other symptoms that have been reported are: gastric irritation, loss of weight, insomnia, apathy, premature menstrual flow, toothache, an urticarial rash, hemorrhages in the skin and mucous membranes, hematuria and anuria. The most severe case on record, that of Gross, did not prove fatal, but convalescence was prolonged. Tolerance may be re-established upon continued use.

Old tuberculous lesions and old foci of osteomyelitis may be stirred up by thiosinamine, which is also contraindicated in the presence of acute inflammation, arterio-sclerosis in the aged (where it may cause congestion), otorrhea, and where useful supporting cicatrices exist.

Locally, thiosinamine sometimes produces, after its injection, a burning sensation, which may persist for hours. The skin may become inflamed or yellowish, or painless nodules may form, later gradually disappearing. Fibrolysin has proven itself less irritant than thiosinamine.

THERAPEUTICS.—Many reports of favorable effects by thiosinamine and fibrolysin have been issued, but likewise many unfavorable ones. The results of administration of the drug by the mouth have, as a rule, been disappointing, and it is therefore generally given by subcutaneous injection in the gluteal, subscapular, or mammary regions, or, preferably, by intramuscular injection into the gluteal muscles, this causing less pain than the subcutaneous injections. To break up dense cicatricial tissues, injection directly into the affected part has been advised, but this is often very painful and may cause marked local edema. The injections are given at one- to three-day intervals, as many as 60 being sometimes given. Fibrolysin should be used in preference to thiosinamine for systemic absorption, though where a local effect is desired, thiosinamine, being less rapidly absorbed, may act more powerfully; fibrolysin injections, however, can be made at shorter intervals than those of thiosinamine.

In the treatment of **scars due to burns**, with marked deformity, and in cases with **fibrous ankyloses of joints**, as from **chronic rheumatism** or **gonococcal arthritis**, marked improvement has at times

been reported from thiosinamine, especially when combined with massage, passive movements, etc. In **keloids** the results have not been as good, only fresh keloids developing on old scars being influenced (Marmoiton). Hebra and others have reported good results in **scleroderma** and in **chronic acne**, Juliusberg in **scars from lupus**, Unna in **smallpox scars**, Glas in **rhinoscleroma**, and Castellani in **mycosis fungoides**. Various authors have lauded its effects upon local injection in **Dupuytren's contraction** (retraction of the palmar aponeurosis), though others noticed no definite improvement. It has also been used in **chronic synovitis**. Neiswanger, for the removal of unsightly operative **scars**, has used a 10 per cent. ointment of thiosinamine in hydrated wool-fat, combined with ingestion of $1\frac{1}{2}$ grains (0.1 Gm.) of the drug 3 times daily. Thiosinamine may also be used locally in 5 to 20 per cent. admixture with soap or plaster (Mears).

Ustimovitch has reported disappearance in five months of a **sarcoma of the neck** in a man 26 years old under 30-minim (2 c.c.) injections of a mixture of thiosinamine, 1 part; glycerin, 4 parts, and water, 5 parts, the dose being gradually increased.

In **esophageal stenosis**, thiosinamine has been reported of value when used in conjunction with bougies. Results in urethral strictures have not been as good as in esophageal. Occasional good results in indurated conditions of the stomach, **pyloric stenosis** and **perigastric adhesions**, have been recorded, and as regards the intestinal tract the remedy has been used with some success in **chronic constipation due to bands and adhesions following laparotomy**, as well as in **cicatricial strictures of the rectum**.

Among respiratory affections the best results have been obtained in **chronic pleuritis** without exudation, and in **thickened pleuræ**. Rénon states that in **pulmonary emphysema** and **chronic fibrous conditions of the lungs** and **pleuræ** thiosinamine perceptibly diminishes dyspnea. Marked improvement has been noted from it in **cicatricial stenosis of the larynx**.

In **chronic aortitis** with stenosis and in-

sufficiency, and in **chronic adhesive pericarditis**, dyspnea is often bettered by thiosinamine (Rénon). In **adherent pericardium with mediastinitis** very marked improvement may be witnessed. In **arteriosclerosis** partial relief from headache and dyspnea is sometimes afforded; the blood-pressure may be gradually reduced by prolonged use of the drug. Lydston has reported a case of chronic renal disease with "phenomenally" enlarged and hardened arteries in a man of 70 years, in which $\frac{1}{2}$ grain (0.012 Gm.) of thiosinamine in a capsule 3 times a day, gradually increased to 1 grain (0.06 Gm.), apparently caused, in about 4 months, a marked reduction in the size and hardness of the vessels (without any change in the blood-pressure).

In diseases of the nervous system the best results from thiosinamine have been seen in cases of **neuritis from scar pressure**. In some **tabetics** it will relieve pain, and in **sclerosing cerebrospinal affections** and **spastic paraplegia**, it sometimes diminishes **contractures** (Rénon).

In gynecology, thiosinamine may be tried to promote absorption of adhesions causing **uterine retroflexion** and **retroversion**, as well as of **chronic inflammatory exudates** in the **parametrium**.

In ophthalmology, good effects have been reported in **leucoma of the cornea** following **keratitis**, in other forms of **corneal opacity**, and in **postneuritic optic atrophy**. **Synechiæ** are improved by the use of mydriatics with thiosinamine, which assists in the absorption of inflammatory exudates of the iris and choroid (Marmoiton). **Cicatricial ectropion**, **symblepharon**, and **cicatricial contractions of the eyelids due to trachoma** were found favorably affected by Saker. The drug may be administered by the customary routes or as an eye-wash of 8 to 15 parts of thiosinamine and 4 to $7\frac{1}{2}$ parts of antipyrin in 100 parts of water, used for 5 minutes twice a day. It is contraindicated in detachment of the retina, vitreous opacities, and all acute inflammatory processes.

In otologic practice, thiosinamine treatment has been applied by Tousey, Lermoyez, and many others, in particular in **deafness** due to adhesions or sclerosis of the middle ear (with the stapes still mov-

able and in the absence of labyrinthine involvement). Lermoyez, introducing hot thiosinamine-autipyrin solution through the external meatus every evening, and also applying systematic massage of the tympanic membrane twice a week, frequently noted an improvement in hearing in 2 weeks, most marked in **cicatricial adhesions following cured otorrheas**, or where a large perforation permitted entrance of the solution into the tympanic cavity. Hitschler, giving thiosinamine internally in similar cases, together with injections into the middle ear through the Eustachian tube, noted improvement in some, but failure in a considerable proportion of instances. The drug has also been used, at times with success, in **aural vertigo** and **tinnitus aurium**. S.

THOMSEN'S DISEASE. See MUSCLES: MYOTONIA CONGENITA.

THORACENTESIS. See CHEST, INJURIES AND SURGICAL DISORDERS OF.

THORACIC DUCT, INJURIES OF. See CHEST, INJURIES AND SURGICAL DISORDERS OF.

THORACOPLASTY. See CHEST, INJURIES AND SURGICAL DISORDERS OF.

THORACOTOMY. See CHEST, INJURIES AND SURGICAL DISORDERS OF.

THORAX, WOUNDS AND INJURIES OF. See CHEST, INJURIES AND SURGICAL DISORDERS OF.

THORIUM. See X-RAYS AND RADIUM.

THREAD-WORMS. See PARASITES: OXYURIS VERMICULARIS.

THROMBOSIS. See VASCULAR SYSTEM, SURGICAL DISEASES OF.

THRUSH. See MOUTH, LIPS, AND JAWS: PARASITIC STOMATITIS.

THYMOL.—*Thymol*, U. S. P. (thymol; thymecamphor; thymic acid; methylisopropylphenol), is a phenol present in the volatile oil of *Thymus vulgaris*, a garden-herb of Europe. Its chemical formula

is $C_6H_3(CH_3)(OH)(C_3H_7)$. It is obtained commercially from oil of ajowan. Thymol occurs in large, colorless, translucent crystals, having a thyme-like odor, and a pungent, aromatic, slightly caustic taste. It is freely soluble in alcohol, ether, chloroform, glacial acetic acid, and oils, but requires 1100 to 1200 parts of water for aqueous solution. Its dose ranges from 1 to 2 grains (0.06 to 0.12 Gm.).

Olcum thymi, U. S. P. (oil of thyme), often misnamed oil of origanum, is a volatile oil distilled from the leaves and flowering tops of *Thymus vulgaris* and containing, when assayed by the official process, not less than 20 per cent. by volume of phenols. It occurs as a colorless liquid with a strong odor of thyme and an aromatic, afterward cooling, taste. It is soluble in one-half its volume of alcohol, in 1 to 2 volumes of 80 per cent. alcohol, and in ether and chloroform. Dose, 3 minims (0.2 c.c.), chiefly used externally.

Thymolis iodidum, U. S. P. (thymol iodide; dithymol diiodide) is identical with Aristol (*q. v.*). Thymol salicylate (thymyl salicylate; thymosalol; salithymol), unofficial, has been used as a substitute for phenyl salicylate (salol), but presents no advantage over the latter, being weaker in action, though less toxic.

PHYSIOLOGICAL ACTION.—Locally, thymol is irritating, but, like phenol, also analgesic. It is less irritant to open surfaces than phenol, though, according to most observers, more strongly toxic to the micro-organisms of putrefaction. It is less soluble in the body fluids than phenol, and is, therefore, less rapidly absorbed.

Taken internally, thymol acts much like phenol, though in toxic doses it causes less central nervous stimulation (manifested in convulsions) than the latter. Used repeatedly in doses of 20 to 30 grains (1.3 to 2 Gm.) per diem it causes epigastric heat, at times accompanied by diaphoresis, tinnitus, deafness, frontal discomfort, diarrhea, and occasionally nausea and vomiting. The urine is discolored greenish or brownish. Continued ingestion of thymol in small doses brings about emaciation. Large amounts depress the central nervous system and reduce reflex

action, lower the blood-pressure and temperature, and may induce fatal coma.

Only an infinitesimal proportion of ingested thymol is excreted with the feces (Schultz and Seidell). This would indicate that thymol is almost completely absorbed from the alimentary tract. According to the experiments of Seidell (1915) in dogs and in human subjects being treated for hookworms, however, only one-third to one-half the amount ingested can be recovered (as thymol glycuronate) from the urine. The remaining one-half to two-thirds is apparently destroyed or temporarily fixed in the body, or is, possibly in part, eliminated through the lungs.

UNTOWARD EFFECTS AND POISONING.—Stiles and Boatwright (1913), administering thymol 464 times to 243 hookworm patients in doses of 5 to 60 grains (0.3 to 4 Gm.)—usually 10 to 20 grains (0.65 to 1.3 Gm.)—noted ill effects after 205, or 44.1 per cent., of the administrations; these ill effects comprising nausea in 66 instances; weakness, 62; burning in the stomach, 45; dizziness or staggering, 44; headache, 14; vomiting, 13; burning in the throat, 8; pain in the "stomach," 7; drowsiness, 5; sickness after discharge from treatment, 3; and dyspnea, irregular heart, and syncope, 1 each. In some instances these symptoms seemed due, in part at least, to the magnesium sulphate used in conjunction with the thymol.

Thymol has in several cases produced death. In a child death has followed 15 grains (1 Gm.); yet, according to Bozzolo, in one adult 225 grains (15 Gm.) were administered in 12 hours without any resulting symptoms of poisoning. Violent delirium has at times been noted in thymol poisoning.

Treatment of Thymol Poisoning.—This consists in evacuation of the stomach with the stomach-tube or an emetic, the giving of a saline purgative and demulcents and the use of respiratory and circulatory stimulants, together with external heat, as required.

THERAPEUTICS.—**Internal and Systemic Uses.**—Since Bozzolo, in 1881, discovered that thymol was efficient in expelling the hookworm, the drug has been

a standard remedy in *uncinariasis*. The most approved plan of treatment consists in giving one or two preliminary doses of magnesium sulphate in the evenings preceding the day of thymol administration, then thymol the next morning divided into 2 or 3 doses, given at 6 and 8, or 6, 7, and 8 A.M., followed at 10 A.M. by another dose of magnesium sulphate. The doses advised are 45 to 60 grains (3 to 4 Gm.) in divided amounts for an adult, given in 5-grain (0.3 Gm.) capsules, and 7½ grains for a child of 5 years. The treatment is repeated once a week until the feces show absence of the parasites. In patients already greatly weakened by hookworm infection Stiles omits the preliminary dose of magnesium sulphate and gives 10-grain (0.6 Gm.) or slightly larger doses of thymol 1 to 3 times at intervals. When the patient has regained sufficient strength by reason of the partial hookworm elimination thus effected, the customary treatment with larger doses is carried out.

Thymol has been used with success in tapeworm parasitism by Campi, Artault, and others. Artault (1913) gives 4 grains (0.25 Gm.) of the drug every morning on an empty stomach for some days. The tapeworm is, as a rule, expelled on the third or fourth day, but the treatment is continued for a week to insure complete elimination, the scolex often being passed unnoticed. Guillon (1913) holds thymol the most reliable, as well as the least expensive, of all teniafuge remedies. After limiting the last meal on the preceding day to milk, he gives in the morning 3 cachets of thymol, each containing 15 grains (1 Gm.) for male adults, 12 grains (0.75 Gm.) for women, and correspondingly smaller doses for children, at hourly intervals, followed, 45 minutes after the last dose, by 1 to 1½ ounces (30 to 50 Gm.) of sodium sulphate. The patient should refrain from going to stool until a distinct need is felt. The effects of the treatment are usually complete 2 hours after ingestion of the purgative. Alcohol and oils, including castor-oil, are to be avoided during the treatment.

Thymol may be given internally with benefit as an intestinal antiseptic in acute and chronic intestinal disorders, including

typhoid fever and infantile diarrhea, according to F. P. Henry, Küssner, Testi, and others. Henry's method of administration is to give the drug, prepared with Castile soap, in 2- to 3-grain (0.12 to 0.2 Gm.) doses every 6 hours. Others have used somewhat larger amounts. The drug may act to some extent as an antipyretic and general sedative in these cases, but its use in large doses for these purposes alone is not warranted, the salicylates being much safer.

Gérone (1915), in order to render typhoid bacillus carriers innocuous, gives 15 grains (1 Gm.) of charcoal half an hour before and 2 7/8-grain (0.5 Gm.) thymol capsules half an hour after meals. The charcoal is intended to delay systemic absorption of the drug and prolong its local action.

Local Uses.—In catarrhal affections of the upper respiratory passages the following inhalant has been recommended:—

R *Thymolis*,
Phenolis,
Mentholis 5â gr. v (0.3 Gm.).
Olci eucalypti 5ij (60 c.c.).
Olci pini 5iij (90 c.c.).

M.

A teaspoonful of the above is added to boiling water and the steam inhaled, or 20 to 30 drops placed on cotton or a sponge and held up to the nose.

As an antiseptic **mouth-wash**, a 1 per cent. solution of thymol in dilute glycerin may be employed, or, as a milder preparation, the official liquor antisepticus, which contains, among other ingredients, minute amounts of thymol. **Toothache** may be relieved by cleansing carious cavities and inserting a bit of cotton dusted with thymol; to dissolve the thymol and hasten its effect the mouth may be washed out with lukewarm water (Hartmann). In **leucorrhea** injections of 1:3000 to 1:1000 thymol solution have proven useful.

Thymol irrigations in **amebic colitis** have been recommended by Musgrave.

In **eczema**, **psoriasis**, **pityriasis**, and **ringworm**, thymol used locally has been found of value. Addition of a little alcohol facilitates the preparation of a 1:1000 aqueous solution, which is usually sufficiently strong. A 2 per cent. ointment

of thymol has been of service in **acne** and **alopecia circumscripta**.

Hoffmann (1912) found a 5 per cent. solution of thymol in 60 per cent. alcohol efficient as a skin disinfectant, and especially advises its use to disinfect the mucous membranes in operative work, notably in gynecology. The application to a mucous membrane should never exceed 2 minutes, and care must be taken to prevent contact of the solution with serous surfaces. In preoperative skin disinfection the solution should be applied 1 hour and again 5 minutes before the operation (Kuhn). Contact of the solution with the perineum or scrotum is to be avoided.

A 50 per cent. alcoholic solution of thymol applied to the hands, neck, and face is effective in keeping off mosquitoes.

Oil of thyme may be employed internally in **bronchial affections** and as a carminative in **colic**. Externally it is useful in **pruritus**, **weeping forms of eczema** (to lessen the discharge), and as a pleasant, fragrant antiseptic for the bath. S.

THYMUS, LYMPHATICS, AND MEDIASTINUM, DISEASES OF.—FUNCTIONS OF THE THYMUS.

Many different functions have been attributed to this organ. An analytical study of all the work done in this connection, however, and personal investigations have shown that each represents a part of its actual rôle and that they may all be grouped more or less within the scope of the function attributed to them in the section on THYMUS ORGANOTHERAPY (volume i, p. 792) viz., that the thymus supplies, through the agency of its lymphocytes, an excess of phosphorus in organic combination (nucleins) which the body, particularly the osseous, nervous, and genital systems, requires during its development and growth, i.e., during infancy, childhood, and adolescence, or later if need be. These nucleins play another important rôle in the body at large, that of taking part in the autoprotective functions of the body—in conjunction with other lymphatic structures.

FUNCTIONS OF THE LYMPHATICS.—These vessels, as is well known,

occur in every tissue and organ of the body supplied with blood-vessels. Their currents flow in one direction only, from the periphery to the center, and discharge into the great veins near the heart the fluids which have been taken up in the solid tissues of the body. Besides absorbing from the blood the vital pabula for the tissue-cells and acting as drains for the waste products of cellular metabolism and detritus of various kinds, these vessels functionate as absorbents from the cutaneous surface, and are the principal carriers of septic materials from the periphery to the central circulation. The serous flow from wounds, which necessitates the employment of drainage, comes from severed lymphatic vessels. The lymphatics are, therefore, involved in all wounds, and form a filter for lymph, but also a protective barrier by opposing, mainly by means of the white corpuscles elaborated by their glands or nodes, the multiplication of bacteria that may have penetrated the skin or mucosa, and to stay as long as possible their progress toward the bloodstream. They become the seat of a violent local inflammatory process if need be, to protect the body at large.

Besides these important functions of defense, the lymphatics and all normal lymphoid tissues supply (from my viewpoint), through their lymphocytes, nucleins required by all tissues, notably the bones and nerves, in which phosphorus in organic combination is utilized. They carry on functions of the thymus in this particular and without the aid of the latter organ after the involution of this organ at puberty or later.

ANOMALIES OF THE THYMUS AND LYMPHATICS.

—Absence of the thymus has been recorded. This anomaly is usually observed, however, in acephalous monsters. In the latter and also in anencephaly and hemiccephaly the gland may be abnormally small. The lymphatic system shows so many anomalies that it is a question whether a distribution of its channels and glands that may be regarded as exactly typical exists. This applies especially to the smaller vessels which are here and there absent, to be replaced by a network of small channels. The more striking anomalies are those of the duct.

It may be double; it may form a fork, the extra arm of which opens into the right subclavian vein, while the left as usual opens into the subclavian of the corresponding side, or into the right subclavian vein, the right internal jugular, etc. Again, a large terminal plexus may send channels to the nearest venous channel. The importance of these anomalies lies in the fact that a wound, say of the right side of the neck, may involve a large lymphatic channel where, under normal circumstances, such should not be the case. This teaches that in surgical work we cannot depend upon the classic distribution of the lymphatic vessels and nodes.

DISEASES OF THE THYMUS.

Although considerable literature on diseases of the thymus is available, it may be said that apart from status thymolymphticus, treated below, very little is known concerning them. It may, however, become involved in general infectious **tuberculosis**, for instance. So rarely does this disease occur primarily in the thymus, that Rolleston could find but one case on record. **Syphilis** with the thymus as primary seat is also rarely witnessed. In both these morbid processes, the thymus may become the seat lesions in common with other organs. Primary **tumors** of the thymus are seldom met with, but this is compensated for by the variety of growths which may extend to it. These include various forms of *sarcoma*, especially those peculiar to the lymph-nodes at large, and *lymphadenoma*, *carcinoma*, *cysts*, and *teratoma*.

Inflammation and abscess are not infrequently met in the course of certain infections, particularly pericarditis, pleuritis, pyemia, and Ludwig's angina. Irrespective of a true inflammatory process, are **focal hemorrhages** which may occur in the course of typhoid fever, diphtheria, and the exanthemata. These are important in the sense that they may become starting points for fibrous areas which impair the functions of the organ sufficiently in some cases to inhibit the physical and mental development of the child and to so reduce the nutrition of the osseous system as favor the development of *rhachitis* and other osseous disorders.

ENLARGEMENT OF THE THYMUS AND LYMPHATICS.

This condition is not uncommon, particularly in children. It is usually termed **status lymphaticus**, but as shown in the present article practically all the symptoms are due to the thymic enlargement in adults, as well as in children. The term **status thymicolymphaticus** is, therefore, to be preferred, and will be used in the present to cover both supposedly different disorders.

STATUS THYMICOLYMPHATICUS.

SYMPTOMS.—The salient symptom of thymic enlargement is difficult respiration, both during inspiration and expiration, but particularly marked during the former. The intensity of the symptom varies, and, although they may merge into each other, three phases have been recognized: *thymic stridor*, *thymic asthma*, and *thymic death*, each of which may occur independently of the others.

Thymic Stridor.—This form, which is often congenital, may become manifest soon after birth, during crying or screaming, and is aggravated when the infant throws its head backward in doing so. It tends to suggest the presence of a foreign body, and may give rise to a perceptible wheeze, which may develop into a suction sound, until it suggests, with the accompanying symptoms, including retraction of the suprasternal notches, an attack of croup—for which it was often taken formerly. Rarely, however, the difficulty is most marked during expiration, and then the latter tends to be vibratory or *saccadée* in character. The stridor is aggravated by the recumbent posi-

tion and somewhat counteracted by lying on the side or sitting up and leaning forward. The stridor may virtually cease after the crying or coughing paroxysm is over, or it may persist in the form of an inspiratory wheeze, which appears greater at times soon after nursing or feeding. It may be stationary or progressive until a condition approaching asthma is initiated. An acute infection, especially diphtheria, pertussis, and bronchopneumonia, is often the starting point of thymic stridor.

Thymic Asthma.—This condition, also known as **Kopp's asthma**, may occur as a progressive aggravation of the former, and may end in death. Sometimes, however, it comes on without antecedent symptoms, and resembles closely violent attacks of asthma, with inspiratory stridor, attended with cyanosis pallor, inspiratory laryngeal stenosis, sometimes accompanied by spasm of the glottis, retraction of the suprasternal space, and of the scrobiculus and thorax. The child throws its head backward and shows all the signs of impending suffocation, with dilated pupils, weak and rapid pulse, etc. In some cases there is also marked dysphagia. Such an attack may pass off completely, or considerable stridor may persist, even though respiration appear normal. Again, repeated attacks may occur in rapid succession, becoming gradually more intense until death supervenes. Temporary, or even permanent, recovery may occur, but, unfortunately, such cases are rare.

Thymic Death.—Under this head are included cases in which death occurs suddenly without previous history of thymic asthma, the thymus being found sufficiently enlarged

post mortem to compress the trachea, the recurrent laryngeal, the vagus, the great vessels of the upper thorax and lower cervical region, and the right auricle. Thymic death occurs not only in children, but also in adults, especially in the latter during coitus, dancing, swimming, etc., and at all ages during or after intense emotional excitement, anger, fright, anesthesia, slight operations, the extraction of teeth, etc. In most instances of thymic death, however, the victim is a child found dead in bed—doubtless as a result of asphyxia, due to tracheal stenosis, laryngeal spasm, or cardiac paralysis—with an enlarged thymus, found at autopsy, as sole evidence. Such cases may be the source of unwarranted accusations of criminal suffocation, and an autopsy should always be performed if possible.

[The mechanical factor cannot be denied in the presence of the considerable evidence accumulated in recent years. Thus, the asphyxia of thymic asthma was completely relieved by Chevalier Jackson when he exposed the gland and lifted it away from the trachea. Various surgeons have also noted that compression and kinking of the trachea could be produced by the thymus, immediate relief following restoration of its normal shape. In a case of Clessin's a pin could be introduced with difficulty through a tracheal constriction caused by thymic pressure. Considerable additional evidence to this effect is available. S.]

An important feature of the disease in point, in view of its fatality in a large proportion of cases, is the recognition of subjects who are liable to it. While some show no symptom capable of affording a suspicion of such a proclivity, the majority do. These have been grouped under the general term of **status lymphaticus**:

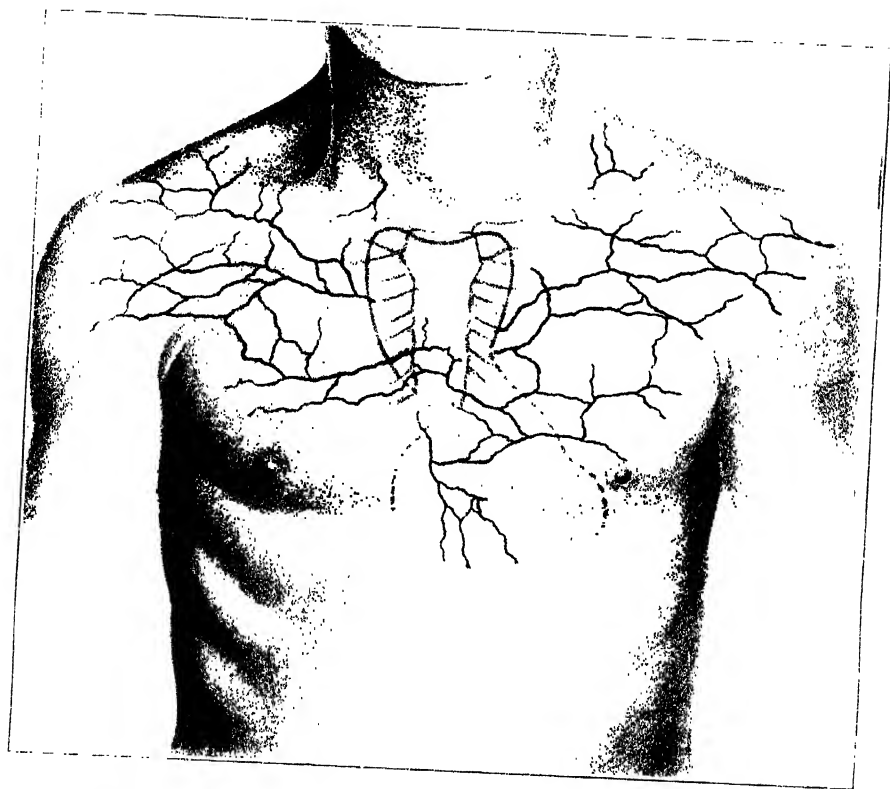
status thymicolymphaticus. While the former indicates that the lymphatic glands may be enlarged without there being enlargement of the thymus, it is likewise true that thymic enlargement may be present irrespective of any involvement of the lymphatics. We have, therefore, two groups of symptoms to identify:—

Thymic Symptoms.—An enlarged thymus may usually be discerned by determining the area of dullness *gentle* percussion affords.

As shown in the annexed plate this area may either be an irregular triangle or heart-shaped, with its base covering the sternoclavicular articulation and its apex somewhere about the third rib over the base of the heart. The boundaries of the area of dullness extend beyond the sternal lines on each side, but practically always more to the left, where the dullness is usually most marked than to the right. If in this location the dullness extends $\frac{1}{2}$ inch or more beyond the sternal line, enlargement of the organ is probable; if, besides this, the dullness can be traced across the sternum, and also obtained to the right of this bone, the presence of a greatly enlarged gland is probable. Bulging of the upper part of the sternum and enlarged veins over the chest (see colored plate) are sometimes witnessed. Laryngoscopy and tracheoscopy, by enabling an expert to locate the site of pressure, are very helpful.

The X-rays, skiagraphy, are useful to establish the diagnosis beyond a doubt. A distinct shadow (following out the line of dullness, as a rule) on the left of the sternum, sometimes as far down as the ensiform cartilage and over the pericardium, is obtained in positive cases.

Auscultation is sometimes of use to detect pressure on the trachea, the edge of the intratracheal projection giving rise to a friction sound when impinged upon by the circulating air during both inspiration and expira-



Venous Engorgement Due to Enlargement of the Thymus. (*Browning.*)

tion. A distinct wheeze may sometimes be detected. Sometimes this sound is reduced in intensity by causing the patient to lean forward during auscultation.

As regards general symptoms traceable to the thymus, their character depends upon the pathological condition present. In some there is hyperplasia of the organ.

[As I have urged elsewhere, a normal gland may greatly enlarge after copious feeding. Such a gland, when its involution has been delayed, or, when it is the seat of hyperplasia, may, after such a meal, become a source of danger if from any cause, coitus, violent exertion, dancing, etc., the resulting rise of blood-pressure further increases the size of the organ. S.]

In certain subjects, the enlarged thymus is no longer composed of its normal elements, but has degenerated into a mass of adipose tissue—virtually a foreign body. Such a gland, in infancy, childhood, and even adolescence, often is inadequate functionally, and gives rise to symptoms of thymic insufficiency.

These in their mild degrees are: 1. Deficient development of the osseous system, bad teeth, etc., sufficient in some instances to suggest the presence of a mild form of rhachitis, due to a deficient assimilation of calcium, a function with which the thymic nucleins are closely connected. 2. Mental indolence and even backwardness, due to the same deficiency of nucleins, which during development are supplied in excess to the nervous system including, of course, the cerebral cells. 3. A low relative lymphocyte count, owing to the inadequate formation of thymocytes—the thymic lymphocytes.

Closely allied with the functions of the thymus are those of the thyroid apparatus. If, as is the case in some patients, there is insufficiency of the former, more or less insufficiency of

the thyroid may also prevail. Hence, the fact that in some cases of status thymicolymphaticus various symptoms of hypothyroidism, sometimes with goiter, appear. There is adiposis, or, rather, thickening of the skin with edema, suggesting the larval type of myxedema; even the brain has been found edematous *post mortem* in some cases. The complexion is pale and pasty, and the patient appears anemic.

Eczema is frequently observed and other eruptions occasionally. Another frequent accompaniment of persistent thymus is infantile development of the genitalia and deficient hair growth. This, likewise, is observed in status thymolymphaticus.

Lymphatic Symptoms.—The superficial lymph-glands, notably those of the neck and axilla, are more or less enlarged. In some cases but two or three lymph-nodes may be hyperplastic; in others, as shown *post mortem*, practically all are involved, the bronchial, intestinal, mesenteric, and retroperitoneal in particular.

[From my viewpoint the hyperplasia of the lymph-glands indicates a compensative hyperactivity to supply the organism at large the lymphocytes and nucleins which the hypoactive or functionless thymus fails to furnish in adequate quantity, and simultaneously to break down as much as possible whatever bacterial or chemical poisons may be present. When their protective rôle becomes inadequate we may have the so-called attacks of "lymphotoxemia," which sometimes occur periodically, as do epileptic convulsions, S.]

The tonsils and lingual tonsil are usually enlarged, and the postnasal space is the seat of adenoids. The spleen is sufficiently increased in size in some cases to become palpable.

and show, under percussion, a considerably increased outline.

On the whole, when the thymus and thyroid are excluded from the pathology of status thymolymphaticus, and the symptoms of secondary or concomitant deficient activity of other ductless glands are taken into account, there is little left, in so far as the lymphatic glands are concerned, beyond their compensative enlargement and any consequence this may entail.

A child or adolescent showing any of the above morbid phenomena and who is subject to attacks of dyspnea on exertion or of laryngismus stridulus is in danger of thymic dyspnea, which may unexpectedly assume proportions leading to fatal asphyxia.

PATHOGENESIS.—That pressure by the thymus causes the stridor, and even fatal asphyxia, is held by most authorities. Conversely, Paltauf, Friedleben and their school have attributed all the morbid phenomena to a toxemia, many clinicians and investigators, including Hart, Rachford, and Pinde, having identified the pathogenic poison as an accumulation of toxic wastes due, in turn, to excessive secretory activity of the gland. It is to the action of these poisonous wastes that they attribute the swelling of the lymphatic nodes and tissues. Klose and Vogt, on the other hand, attribute the morbid phenomena, even thymic death, to an acid intoxication. The enlargement of the lymphatic glands, which occurs as a complication of various diseases, is but a counterpart of the foregoing, the only difference being that a toxin of exogenous pathogenic organisms fills the rôle of toxic.

All these views, apparently so contradictory, are harmonized by my own interpretation of this morbid process. Briefly,

this is as follows in the majority of cases: The presence of an overactive thymus, whether enlarged or not, in a child, or of persistent thymus after puberty when its active participation in the development of the body should virtually have ceased, means a corresponding production of thymic lymphocytes and nucleins over and above the needs of the body. Metabolism being unduly activated, toxic wastes accumulate in the blood which provoke the toxic symptoms observed in status thymicolymphaticus. These toxic symptoms may also be brought on by the toxins of certain diseases.

The excessive production of nucleins increases correspondingly the functional activity of all tissues, including the thyroid and adrenals. The excess of adrenal secretion produced gives rise to the contracted heart, aorta, and peripheral arteries noted in all cases by Bartel and the dilatation of the superficial veins. The overproduction of the thyroid secretion is so marked, owing to the hyperplasia witnessed—sufficient in some cases to give rise to goiter and exophthalmos—that some clinicians have emphasized the resemblance of the syndrome in some cases to that of Graves's disease.

Conversely, where, as is occasionally observed, the glandular hyperplasia has been followed by degenerative changes, atrophy, fibrosis, etc., we may encounter symptoms of larval myxedema and even Addison's disease. A thymus which though enlarged may have undergone adipose transformation may also awaken symptoms of status thymicolymphaticus, including those due to thyroid and adrenal deficiency.

TREATMENT.—In view of the foregoing data the treatment should be governed by the nature of the pathogenic process. The one effective agent is **X-rays**, but if its use coincides with an enlarged thymus rendered deficient through focal degenerative changes, with secondary cretinism, myxedema or Addison's disease, it will do more harm than good.

The untoward effects attributed to this method of treatment appear in some cases at least to have been due to lack of discrimination on this score. Such cases are apt to show a general leucopenia, more or less marked rachitic or cretinic symptoms. Where, on the other hand, such symptoms are absent and there is a relative lymphocytosis or even leucocytosis, the X-rays may prove effective and even curative, as shown by numerous recorded reports.

Complete **thymectomy** is inadvisable in young children, owing to the danger of interfering with their development,—skeletal, mental, and sexual. **After puberty**, especially in adults, the organ is virtually a mass of adipose tissue acting as foreign body; the operation does not offer the same dangers. **Partial subcapsular thymectomy**, ligation of some of the **thymic arteries**, **exothymopexy**, *i.e.*, raising of the organ and stitching it to the sternum, which may readily be combined with partial thymectomy, are available for children, and are usually very effective. The organ being located immediately below the upper edge of the sternum, bulging out even during dyspneic paroxysms, it may easily be reached for stitching. In some cases, however, resection of the manubrium sterni is necessary for partial thymectomy.

Thymectomy Technique.—As performed by C. H. Mayo this procedure is as follows: A curved transverse incision, which includes skin and platysma, is made low in the neck. The inner borders of the attachments of the sternomastoid muscles are incised; the sternohyoids are cut across. If the thymus be enlarged, it is seen as a pinkish gland projecting into the neck from behind the sternum, at least during respiration. The gland may now be caught gently with clamps and drawn upon until the fingers can be used for direct traction. The vessels are not large,

the fascia which incloses the gland is loose, and there is but little difficulty in clamping and ligating as one lobe is removed. If it be deemed necessary, the second lobe can be elevated and a portion of it removed. In a case operated on in the Mayo clinic *only one lobe was removed*. The relief was immediate and yet there were occasional symptoms of pressure for a number of days. The cure was complete. A drain should not be used unless indications for drainage are urgent. In case it be advisable, a folded strip of rubber tissue should suffice for the few hours during which the procedure may be necessary.

Deep intubation is very effective for the alleviation of asphyxic phenomena if the end of the tube reach below the seat of obstruction; short tubes are obviously useless. **Tracheotomy** is effectual under similar conditions, particularly if asphyxia is impending, when **oxygen inhalations** are also employed. **Cold compresses** over the **thymus** and the **upright position** tend to decongest the thymus, and to relieve the dyspnea.

The general measures are ineffectual unless a clear indication for them prevails. Thus, in the presence of myxedematous symptoms, **thyroid gland** is helpful. In others the **iodides** will prove beneficial if a history of syphilis, inherited or acquired, be obtained, and where eczema occurs. In the presence of rachitic symptoms, **calcium lactate** with **thyroid gland** in small doses, often prove beneficial. It is in these cases also that **thymus gland** proves useful.

Any abnormal condition found should be remedied, remembering, however, that **anesthesia** and **operations readily induce death** in such cases, and that **deep intubation** or **tracheotomy** may become necessary at any moment. The parents should

also be apprised of the dangers of operative procedures in such cases.

Prevention of Paroxysms.—As stated elsewhere, copious feeding tends to cause enlargement of the thymus.

In infantile marasmus, on the other hand, the thymus is the seat of so-called atrophy, but one which promptly disappears under appropriate and sufficient food. An enlarged thymus, moreover, may be found completely collapsed *post mortem*. This indicates that the organ structurally resembles a sponge which readily enlarges under suitable conditions, which in the cases in point may menace the patient's life.

Under these conditions, cases in which thymic stridor or asthma prevail should be kept under **low diet**, in so far as meats, eggs and other substances rich in nucleoproteins are concerned. Anything capable of raising the blood-pressure, such as **violent exercise, excitement, crying, screaming**, etc., should be **avoided**. **Cold or hot baths, sea-bathing**, may also **cause sudden thymic death**. A **suitable position**, that in which the little patient breathes with the greatest freedom, whether this is sitting up, lying on the side—the favored positions—or on the back, should be sought, and the patient encouraged to retain it. Throwing of the head backward favors the production of attacks. Unusual care should be taken to assist children having an enlarged thymus, in the **avoidance of acute infections**, and thereby hyperemia of the gland. Another important feature is to **avoid constipation** by suitable measures, and, if possible, to insure for the patient an **out-of-door life in a mild climate**, where catarrhal disorders of the respiratory tract may be prevented.

DISEASES OF THE LYMPHATICS.

The functions of the lymph-glands, to act as filters for the lymph and protect the blood against all harmful agents that may come from the cellular spaces or penetrate the lymphatic stream through the cutaneous covering, bring them into contact, as may be surmised, with a multitude of pathogenic factors. Under normal circumstances they protect the body without showing, through an increase in size, evidence of overactivity. When, however, an unusual reaction becomes necessary, enlargement occurs and persists as long as needed to successfully oppose the pathogenic agent. Exaggeration of this activity is the underlying cause of most of these diseases.

LYMPHADENITIS.

This is an inflammation of the lymph-glands due to violent defensive activity provoked by an accumulation in them of pathogenic bacteria or poisonous substances. It may recede when the invasion of these morbid agents ceases, or proceed to suppuration with necrosis of the lymphoid elements, when its phagocytic cells are overcome by the pathogenic agent.

Lymphadenitis may be *acute* or *chronic*. It may occur as a result of virtually any disease due to bacteria or parasites. Even vaccinia may awaken a severe reaction of the axillary glands, though suppuration here is due to infection of the vaccine lesion. Rubella is another mild disorder in which lymphadenitis may occur. Among the parasitic diseases in which lymphadenitis is witnessed are malaria and trypanosomiasis may be mentioned. Buboes, whether gonorrheal or chancreoidal, or as features of bubonic plague, probably represent the most aggravated forms of lymphadenitis.

The various forms of this disease, including ACUTE and CHRONIC LYMPHADENITIS and TUBERCULOUS LYMPHADENITIS, have been reviewed in the article on ADENITIS in the first volume, page 374, to which the reader is referred. TUBERCULOSIS OF THE BRONCHIAL GLANDS is considered below with the diseases of the mediastinum.

LYMPHANGITIS.

Lymphangitis, also termed **angio-leucitis**, is an inflammation of the lymphatic vessels due to infection by organisms and toxic materials of various kinds. It is usually divided into two forms, **capillary** or **reticular lymphangitis**, when the superficial lymphatic capillaries are alone affected, as in erysipelas; and **tubular lymphangitis** when the larger ducts and trunks are involved in the morbid process, as is the case after snake-bites, septic wounds, etc.

SYMPTOMS.—What constitutional symptoms appear are dependent upon the severity and extent of the infection. The patient may be seized with rigors, followed by fever, attended, not infrequently, by vomiting and diarrhea. These symptoms may precede the local signs of the disease by 12 or 14 hours, but frequently accompany them. Examination of the region, if superficial, will reveal a number of fine, red streaks, at first scattered, but gradually approaching one another so as to form a distinct band, about an inch in breadth, running from the affected part along the inside of the limb to the neighboring lymphatic glands, which have become enlarged and tender. The band itself feels somewhat doughy and thickened. More or less

edema of the limb is present, owing to involvement of the deeper layers of the vessels and their obstruction by the inflammation. Erysipelatous patches not infrequently appear along the course of the inflamed absorbents, and coalesce until they are of considerable size. If the deeper-seated lymphatics are first implicated, the glandular signs are first observed; if the inflammation continues to be confined principally to the deep vessels, it gives rise to a great and brawny swelling of the limb, with much, if any, superficial redness. The constitutional symptoms, at first of an active form, may gradually subside into the asthenic type.

The disease usually terminates in resolution at the end of a week or ten days; exceptionally it may terminate in erysipelas. In some cases limited suppuration may take place or a chain of abscesses form along the course of the lymphatic vessels and glands. In other cases, after the disappearance of the inflammatory symptoms, a state of chronic and rather solid edema (**lymphedema**) is left, giving rise to a species of false hypertrophy resembling **elephantiasis** in some cases. **Lymphadenitis** may occur as a complication, owing to deposition in the glands of septic or infective materials, and give rise to pain and swelling, sometimes suppurative, accompanied in some cases by chills and even septic fever. More rarely death results from erysipelas, pyemia, or from secondary abscesses, especially in patients with impaired constitution, in whom the disease has been extensive and has become associated with low cellulitis.

DIAGNOSIS.—The diagnosis of superficial lymphangitis is usually

easy. The tender red streaks indicate the tubular variety. The diffuse redness of the reticular form, with its superficial edema, tenderness, and constitutional symptoms, differentiate it from **erythema** or **dermatitis**. From **phlebitis** it is distinguished by its superficial redness, the inflammation of contiguous glands, and the absence of the knotted corded state which belongs to an inflamed vein; the pain and fever are usually less in phlebitis. Inflammation of the deep lymphatics is not easily differentiated from **cellulitis**; if glands are early involved, if lymphatic edema is present, if patches of reticular lymphangitis appear at points of anastomosis with deeper trunks, inflammation of the deep lymphatics may be assumed.

ETIOLOGY.—The etiology of the reticular variety has already been referred to. Tubular lymphangitis is always caused by the entrance into the affected duct of bacteria and bacterial products of more than usual virulence. The absorption of septic matter from infected wounds always follows, but does not generally cause an extensive inflammation of the lymph-channels; a lowered vitality, asthenia, etc., which entail defective defensive activity, predispose to it. Frequent irritation of the infected wound and retention of septic secretions in it are frequently exciting causes. Trivial wounds may be infected with virulent septic material (snake-bites, dissection wounds). Bathing the hands in putrid fluid for some time, without any discernible breach of surface, has been followed by lymphangitis.

TREATMENT.—Lymphangitis being a septic disease, the treatment should be conducted on antiseptic

lines. The original wound, through which the septic virus has gained entrance into the lymphatic circulation, should be thoroughly **cleansed** and **disinfected** with **iodine**, **ichthyol** or **blue ointment**. The affected limb should be **elevated** and kept **quiet** and **warm**. **Free incision** will relieve any tension, and is advised even before the appearance of suppuration. All **foci of suppuration** should be evacuated by incision, **disinfected**, and **drained**. **Extirpation of the gland** is sometimes necessary. **Compresses** wet with an aqueous **solution of bichloride of mercury** (1:2000) should be laid upon the affected parts, the compresses being remoistened as they begin to dry, and reapplied until the inflammation has entirely disappeared.

The constitutional symptoms usually demand more or less attention, especially in the direction of support. **Quinine** and **nux vomica** are helpful in this connection. **Free elimination** should be insured by means of aperients. **Opiates** may be needed to relieve pain, but their use should be avoided if possible, as they diminish the secretions. The **mineral acids** and bitters are useful, as digestion is usually impaired. **Nourishing food** should be freely administered, and **stimulants**, such as **milk-punch**, given in the more severe cases. **Bandaging** and **massage** will best overcome any edema which may be left after the **acute symptoms** have subsided.

LYMPHANGIECTASIA; LYM-PHANGIOMA.

While *lymphangiectasia* means dilatation of the lymphatic vessels due to obstruction, *lymphangioma* means an advanced stage of lymphangiectasia

in which the dilatations are large and tend to form a tumor.

SYMPTOMS.—**Lymphangiectasia** may occur in the superficial and deep lymphatic networks and in the lymphatic trunks. The inner side of the thigh is the favorite location for this disorder, but it has also been seen in the anterior abdominal walls, about the ankle- and elbow- joints, and on the prepuce. In the superficial lymphatics this condition appears first as small elevations, giving the skin an appearance like the rind of an orange; subsequently it appears as small vesicles covered with a thin layer of epidermis. The larger lymphatic trunks are, at the same time, frequently affected similarly. The vessel may either be dilated cylindrically into round, beaded enlargements, often semitransparent, and but slightly compressible, or ampullæ may be formed on them, giving rise to more or less soft swellings, fluctuating under the finger. There is usually some edema either from obstruction of the lymphatics or from the impeded flow of the lymph; the affected parts may become swollen by a hard, compact, brawny edema which is not reducible by position or pressure, *lymphedema*. This condition may lead up to *elephantiasis* (q. v.). Areas of lymphangiectasia are liable to attacks of erysipelas, doubtless owing to the diminished resistance they offer to pathogenic organisms.

In a majority of recorded cases a discharge of lymph, *lymphorrhagia*, has been observed, caused by a rupture of the vesicles. It varies in amount and duration, and is apt to be intermittent in character. Another form of lymph-discharge which occurs normally from all wounds as

a result of rupture or incision of the lymph-radicles or smaller trunks is known as *lymphorrhœa*. An excessive discharge of lymph, in either manner, provokes symptoms of general debility like those induced by hemorrhage. Rupture of a dilated lymphatic along the urinary tract and the consequent lymphorrhagia produce *chyluria*. If the tunica vaginalis testis be the seat of a lymphorrhagia, *chylocele* results.

Lymphangiomata, varicose lymph-vessels, may form lymphatic nevi, which are slightly raised from the skin, and are either colorless or pinkish, giving off lymph when punctured. These are due to blocking of the lymph-channels of the affected area. Varicose swelling of the lymphatics in the inguinal regions may simulate hernia. In any region, however, it may form a tumor, *cavernous lymphangioma*, the spaces of which are filled with lymph. Dilatations of the blood-vessels may coexist with those of the lymphatics, producing a mixed tumor. When such mixed growths occur in the tongue they produce an enlargement of the organ known as *macroglossia*; when occurring in the lips, this enlargement is known as *macrocheilia*.

ETIOLOGY.—Both lymphangiectasia and lymphedema are often congenital owing to defective development or to obstructions to the lymph-stream, of a mechanical or inflammatory nature, during intra-uterine life. Inflammation and thrombosis are the usual causes of the acquired variety, resulting in a dilatation of the radicle and primary channels, with lymph-stasis and edema of all the tissues supplying the narrowed or occluded vessels. Cicatricial contraction, pressure by tumors,

or occlusion of the lymph-channels by tuberculous or cancerous material may also be etiological factors in this condition. In a large class of cases occurring in tropical regions, the presence of the *Filaria sanguinis hominis* in certain lymphatic vessels has been shown to be the cause of lymph-thrombosis and inflammation.

TREATMENT.—Circumscribed dilatations and isolated cystic enlargements may be removed by **excision**. **Massage**, the **elastic bandage**, and support in an **elevated position** will give relief in the diffused dilatations and edema due to persistent obstructive causes, in cases in which collateral lymphatic circulation may become sufficiently developed to relieve the stasis; when such collateral circulation is not developed and stasis is not relieved, these means will not suffice. If all other means fail, **ligation of the main artery** of supply to the limb would be justifiable. In a few recorded cases rapid improvement has followed; in others none. **Amputation** may be done, if the condition is confined to an extremity and causes serious annoyance. Similar tumors involving the genitals should be excised, care being taken to preserve the penis and testes by dissecting them out of the diseased mass. The use of the **elastic bandage** about the base of the growth will prevent hemorrhage during the operation and facilitate the dissection.

TUMORS OF THE LYMPHATIC SYSTEM.

Tumors of the lymphatic system include both benign and malignant growths. Among the former may be mentioned the **lymphadenoma**, which is limited to the gland itself, and is

due to simple hyperplasia of the glandular elements. The more common form, however, is the **lymphangioma**, which comprises various nevi, moles, etc., of the skin and tongue. The cystic tumor occasionally observed on the neck, **hygroma**, **cysticum colli**, and the **lymphangiomatous cysts**, which occur on the arms, trunk, mesentery and thighs, are congenital, as a rule, and occasionally interfere with delivery owing to the large size.

The malignant growths include **Hodgkin's disease**, or **pseudoleukemia** (treated in full, page 346, in the sixth volume). Another growth of this class not infrequently met with is the **lymphangioma hypertrophicum**, or **fleshy wart**, which may arise from the lymph-space of practically any tissue. These growths may, and usually do, run a benign course; but they occasionally undergo malignant change, particularly in serous membranes. **Lymphosarcoma** or **sarcoma** of the lymphatic glands is occasionally observed. In its early stages it differs little from other glandular hypertrophies, but later it manifests its malignant character by involving adjacent tissues and by the appearance of secondary deposits in the various internal organs.

As is well known, the lymphatic vessels spread carcinomatous and other cells, thus causing secondary growths of the lymphatic glands. These, however, are reviewed under the headings of the causative diseases.

TREATMENT.—In all these diseases **excision** should be resorted to where possible, especially where the possibility of malignancy present or remote exists. **Electrolysis** and **X-rays**

have proven to be the most active measures for the removal of benign growths when surgical intervention is refused or is impracticable. Various measures employed in the treatment of angiomata (*q. v.*) may also prove efficient. In *lymphosarcoma*, **Coley's fluid**, $\frac{1}{2}$ minim (0.03 c.c.), gradually increased until 10 minims (0.6 c.c.) are injected into the growth, have given good results (Spencer). **Radium** is recommended by Kelly and Burnam, Turner, Abbé, and others, in this disease. **Benzol** was found effective by Moorhead, 1 dram (4 c.c.), rapidly increased to 5 drams (20 c.c.) being given, with **X-ray** exposures twice weekly.

GLANDULAR FEVER.

This is a contagious and sometimes epidemic disease of children and debilitated adults, characterized by a marked febrile movement, and enlargement and tenderness of the cervical lymphatic glands, and sometimes of the axillary, inguinal, mediastinal and mesenteric glands.

In an epidemic of glandular fever that occurred among the inmates and employes of the Northern Indiana Hospital for the Insane, in the winter of 1904-5, the notable features were, according to F. W. Terflinger, Logansport, Ind. (*Jour. A. M. A.*, March 7, 1908), the number of persons attacked (150) and their ages, ranging from 18 to 80. This disease has been considered a disorder of childhood. Sex, age, and occupation had no influence, but in adults complications and sequelæ were rare.

SYMPTOMS.—The onset is sudden, pain on moving the head and neck and sometimes chills being, as a rule, the first noticeable symptoms. There may be some abdominal pain, accompanied by nausea and vomiting. The temperature ranges from 101° to 104° F. (38.2° to 40° C.). The

tonsils and the pharynx may be congested and the lymphatic tissues swollen, but the throat symptoms are usually of short duration. The glandular enlargement appears on the second or third day, and while it lasts the glands, especially those along the border of the sternocleidomastoid muscle, may vary in size from a pea to a goose-egg. The glands are painful to the touch or pressure, but there is rarely any redness or swelling of the skin covering them, though there may be, occasionally, some puffiness of the subcutaneous tissues of the neck and a slight difficulty in swallowing. The submaxillary, axillary, inguinal, mesenteric glands, the liver and spleen may also be enlarged and tender.

The muscles of the neck may be painful and stiff. When the tracheal and bronchial glands are involved there may be a feeling of discomfort in the chest, with a spasmodic cough. There is usually marked pallor, though the blood-count may show no abnormality. The glandular swelling usually continues two or three weeks. The complications reported in this disease are suppuration of the swollen glands, hemorrhagic nephritis, acute otitis media, and retropharyngeal abscess. The convalescence, as a rule, is quite slow, but on the whole the prognosis is favorable.

ETIOLOGY.—Although doubtless due to some pathogenic organism, it is doubtful whether any specific germ can be incriminated. The prevailing view is that pyemic infection with the streptococcus as main agent underlies the disease, and that the main source of infection is the upper respiratory tract.

TREATMENT.—The treatment is on the whole symptomatic, but from my viewpoint small doses of **calomel** at the onset tend to shorten the duration of the disease by enhancing the bactericidal and antitoxic power of the blood and its phagocytic cells. Locally, **belladonna ointment**, or **guaiacol**, painted over the swollen glands seem to give the best results. While the bowels should be kept free, **mild aperients** are alone necessary, as active catharsis tends to debilitate. **Saline solution enemas** are alone necessary in most instances. The **strontium salicylate** has been recommended to combat directly the pathogenic agent or agents.

MEDIASTINUM, DISEASES OF THE.

The diseases of the mediastinum, the space formed by the sternum in front, the vertebral column, from the fourth dorsal down behind, the diaphragm below, and the pleura on each side are considered in the present connection because most of the tumors which grow therein start from remnants of the thymus, while its lymphatic glands are, of all its structures, those most frequently diseased. These are with relative frequency the seat of tuberculosis, of abscesses which may compromise life.

ACUTE AND CHRONIC MEDIASTITIS.

Inflammation of the connective, adipose and glandular tissues which surround the mediastinal organs may be acute or chronic.

Acute mediastinitis may occur as a result (1) of traumatisms, blows upon or crushing of the chest or back, penetrating wounds, etc. (see CHEST, INJURIES OF), which often lead to the formation of abscesses that are dangerous to life, because the mediastinum is a closed space surrounded by

vital organs, and difficult of drainage; (2) of extension of neighboring inflammatory processes of the lungs and pericardium, especially in acute pericarditis (see Mediastinopericarditis in the article ON HEART AND PERICARDIUM, DISEASES OF), lobar pneumonia, acute pleurisy and peritonitis—the diaphragm in the latter disease being the pathogenic intermediary—acute osteomyelitis of the chest-walls; tracheal, esophageal and bronchial abscesses, ulcerations, etc., which open into either mediastinal space; and (3) of metastasis, such as may occur in pyemic and infectious pyemia, septicemia, erysipelas, typhoid fever, smallpox, etc. This process represents, in some cases, but an extension of a general lymphadenitis, being restricted to the mediastinal lymph-glands.

Chronic mediastinitis may occur as a sequel of the acute form, but the most frequent cause of chronic mediastinitis is tuberculosis of the mediastinal lymph-glands—the **tuberculous lymphadenitis** of this region—occurring as a complication of pulmonary or osseous tuberculosis (especially in Pott's disease). Cancer may also lead, probably through metastasis to chronic mediastinitis. Syphilis is, next to tuberculosis, the most frequent cause of this condition and in adults probably the most usual etiological factor, when aneurism, which often involves the mediastinum, is taken into account.

These various morbid conditions lead to the formation of granulations, fibrous adhesions, etc., and the resulting compression upon, constriction or distortion of, the various structures the mediastinal spaces contain, the thoracic duct and lym-

phatic glands, the mediastinal veins and rarely the esophagus and trachea.

SYMPTOMS.—**Acute mediastinitis**, unless it be due to injuries, is difficult to recognize when mild. When the inflammatory process is severe or widespread in the areolar tissue of the cavity, local symptoms may be identified. The most important of these at first is oppression in the chest, then throbbing, sometimes burning, substernal pain, aggravated by motion and breathing, which extends through to the back and in some cases radiates along the intercostal nerves, or, as does angina pectoris, toward the shoulders. The distant pains are doubtless due to pressure, which plays an important part in the symptomatology of some cases. Thus we may have dyspnea and cough, owing to pressure upon the trachea and larger bronchi; dysphagia owing to compression of the esophagus; rarely, enlargement of the superficial veins and cyanosis of the lips, through pressure on the venous trunks. These symptoms are added to those of the causative malady, the febrile process of which is aggravated. Acute mediastinal inflammation, when not severe, usually declines after a week or ten days. Severe cases may last as long as the causative disorder, or lapse into the chronic form.

In **chronic mediastinitis**, the formation of fibrous tissue, which not uncommonly follows lobar pneumonia, syphilis, rheumatic fever, and other diseases, may give rise to symptoms which vary with the parts constricted or compressed. Often, however, the subjective symptoms are rare and vague, a sensation of pressure behind the sternum with slight pain, which the patients sometimes describe as

"burning,"—probably due to reflex hyperchlorhydria,—and some dysphagia, being about all the patients can recall. Or, distressing symptoms such as dyspnea, marked cyanosis, severe dysphagia, due to pressure of enlarged glands on the trachea or upper bronchi, may occur; again, laryngeal symptoms such as hoarseness, laryngeal paralysis, unequal pupils suggesting pressure upon the recurrent laryngeal or sympathetic nerves—probably of syphilitic origin—may vary the picture. But even the more common types of chronic inflammation of the mediastinal areolar tissue and glands may mechanically awaken serious symptoms, cough, periodical attacks of dyspnea, vertigo, substernal pain, engorgement of the superficial veins and even syncope. Non-tuberculous enlarged glands, due to the many causes mentioned may, moreover, give signs which, as emphasized by Honeij, of Cambridge, are often mistaken for those of apical tuberculosis.

Abscess of the mediastinum is a frequent complication of both acute and chronic mediastinitis. Irrespective of that due to tuberculosis of the lymph-nodes, it may appear in the course of erysipelas, empyema, the eruptive fevers and other febrile disease—the whole series capable of provoking mediastinitis, particularly traumas. It may also occur as an extension of purulent processes in neighboring regions, the neck, vertebral column, sternum, ribs, lungs, pleura, esophagus, pericardium, etc. Substernal pain extending to the back, fever, sometimes preceded by chills, sweating, rapid and sometimes irregular pulse, and, if the affected mass and its purulent accumulation be

large, more or less dyspnea. Bulging of the chest-wall and a pulsating mass which sometimes affords fluctuation at the edge of the sternum or in the suprasternal notch on gentle percussion, and is sensitive to pressure, is occasionally observed. After remaining localized for a time the abscess may cause erosion of the sternum or break externally above it, or again burrow along a rib and through the skin, but it may also rupture into one of the adjacent organs,—the esophagus, when vomiting of pus will occur; the trachea or bronchi, when dyspnea, cyanosis and even fatal asphyxia may occur, unless the pus be voided by coughing. The pleura, pericardium, abdomen, etc., and even the large blood-vessels, may thus become invaded. Where the opening occurs externally and not too far from the sternum a fistula may form, affording drainage without, however, procuring recovery.

Tuberculous Mediastinal Lymphadenitis.—Of the chronic disorders of the mediastinum, this is by far the most common, particularly in children. In these, irrespective of any actual pulmonary disease, a persistent cough, resembling that of pertussis and apt to be most severe at night, may be due to such glands in part owing to the pressure exerted by them upon the adjoining bronchi, and irritation of their sensory nerves. These glands *may or may not* be tuberculous, but it is *always best to base the treatment upon the theory that they are tuberculous*, so frequently does such prove to be the case, even where the common causes of mediastinal tuberculosis, pulmonary or osseous tuberculosis, cannot be discerned. This is important also be-

cause such glands act very frequently as foci for general infection and tend to form abscesses and rupture into the adjoining respiratory passages, the trachea and upper bronchi particularly; also in blood-vessels, the esophagus, pleura, pericardium, etc., and to cause sudden death by asphyxia, cardiac arrest, etc. Or, a fistulous opening into these various cavities or through the skin may be formed, as we have seen. Besides the spasmodic cough we may then have a variety of symptoms which may at one time or another suggest practically all thoracic diseases, including pulmonary tuberculosis, emphysema, and cellulitis, chronic bronchitis, a neoplasm and even aneurism in the mediastinal area. Prominent among these signs may be mentioned dyspnea, dysphagia, dilatation of the superficial veins or at least of the larger venous trunks, cyanosis, hoarseness, and even aphonia; sensation of constriction of the chest; pain radiating to the back, somewhere between the first and fourth dorsal vertebrae; tenderness over the mediastinal, irregular heart action, remittent pyrexia, and emaciation—all these supplementing whatever tuberculous process (primary or secondary) may exist elsewhere.

Tuberculosis of the Bronchial Glands.—This subject appears in this location because of the proximity of the bronchial glands to those of the mediastinum, and owing to the fact that the symptomatology, physical diagnosis, and treatment of tuberculosis of these glands are practically those of tuberculosis of the corresponding structures.

As is the case with the mediastinal glands, the bronchial glands are fre-

quently involved in infectious diseases, pertussis, bronchopneumonia, bronchitis, measles, influenza, and other infectious diseases. In all of these, however, resolution usually occurs, and no untoward effect follows. This does not apply to tuberculosis of these glands, primary or secondary, which is of *common occurrence in children and always a menace*, through dissemination of the tuberculous process, not only to the lungs, but also to the meninges. Bronchial tuberculous glands are prone also to suppurate, and by breaking into neighboring large vascular trunks, venous and arterial, a bronchus, the pleura or the pericardium promptly entail death. It may extend also to all the lymphatic nodes of the thorax, etc., giving rise to all the phenomena of acute phthisis, and also to the mesenteric gland, thus causing abdominal tuberculosis, etc. In all such cases the outlook is serious, unless active measures be taken to stay the morbid process. Hence, the importance of a correct diagnosis *early* in these cases. The physical signs enumerated under **diagnosis** are of great aid in this connection, in addition to the tuberculin and other tests.

DIAGNOSIS.—Apart from the symptoms enumerated, but few physical signs are helpful when tuberculosis (see below) of the mediastinal lymph-glands is excluded. In chronic mediastinitis, laryngeal tug-ging attributed to traction by the secondary fibrous bands has been observed by some; others refer to retraction of the chest-wall over the area when fusion with the pleura or pericardium has occurred. Conversely, bulging of the chest-wall is not infrequent, thus introducing a pos-

sibility of confusion with abscess and aneurism of the mediastinum. The fact, however, that fibrous mediastinitis is, in the majority of cases, due to tuberculosis of its lymphatic nodes, suggests that the many physical signs available for the recognition of the latter may prove of service in the present connection, particularly where enlarged glands containing purulent masses are concerned. Radiography and bronchoscopy are sometimes helpful.

Physical diagnosis as developed in the study of tuberculous mediastinitis may be said to be useful in all mediastinal disorders.

Percussion, using the distal joint of the middle finger as pleximeter and striking lightly, is especially helpful. Anteriorly, however, the presence of the thymus in children tends to introduce confusion, while a substernal goiter may also mislead, both by eliciting dullness.

Dullness over the sternoclavicular articulation ceasing beyond the sternal margin is another sign elicited by thymic and thyroid enlargement. When, however, besides clearly defined dullness in these locations, we also obtain it in the back, from the first to the fifth or sixth vertebral spine (as well emphasized by John C. Da Costa, Jr.) and laterally to the middle of the scapula, the area below this level affording clear resonance, the probability of the presence of enlarged mediastinal glands is very great. In the presence of the other symptoms enumerated above the diagnosis of enlarged mediastinal or bronchial glands is virtually warranted.

Strongly corroborative are certain signs brought out by auscultation.

D'Espine's sign is one of these; while normally the whispered voice is conveyed to the ear down to and including the seventh cervical vertebra, then becomes weaker, the presence of enlarged lymph-glands reduces the limit of sound transmission to the fourth and even the third vertebra. Again, both inspiration and expiration may be found to cause rhonchus about the bifurcation of the trachea (*Rilliet's sign*) when the glands are greatly enlarged. A venous hum when the head is thrown back (*Eustace Smith's sign*) is sometimes obtained quite plainly when the glands are large enough and so situated as to compress the vessels in or adjacent to the area involved. *Perez's sign*, a mediastinal friction sound during each respiratory movement, may also be obtained in some instances. On inspection engorged branching veins (see colored plate opposite page 536) are occasionally observed; the chest-wall may show some localized bulging, while the motions of the chest on the corresponding side may appear restrained. Radiography is sometimes elucidative by furnishing unusual shadows.

The tuberculin test should always be employed if there is any doubt concerning the presence of tuberculosis. If this proves negative, a Wassermann should be resorted to, chronic mediastinitis being in most instances due either to syphilis or to tuberculosis. Bronchoscopy is sometimes of service to indicate distortion of or pressure upon the trachea, but the possibility that an abscess might be present precludes measures that subject the patient to undue manipulations or fear, especially as is often the case if the sufferer is a child.

TREATMENT.—In *acute* mediastinitis the treatment is that of the causative disorder with such local applications—**cold compresses**, etc.—as will tend to give the patient comfort. If **saline solution** is not used in the causative acute disease and is not contraindicated, **hypodermoclysis** or at least **enteroclysis** should be tried. By increasing the osmotic properties of the blood and reducing its viscosity, it facilitates its passage through the lymph-glands and promotes thereby resolution of those that are the seat of an inflammatory process.

In the *chronic* form Sergeant's dictum that practically all non-traumatic cases that are not clearly due to extension of neighboring and identifiable disorders are due to hereditary syphilis or tuberculosis, should guide at least the first efforts at treatment. The **iodides**, **biniodide of mercury**, and even **mercurial inunctions** should be tried, even if the Wassermann reaction is negative, where the possibility of inherited syphilis exists. **Thyroid gland** is often useful in these cases.

When *abscess* occurs **incision** and **drainage** are indicated. It may be reached anteriorly either by an incision between the ribs or by **trephining** the sternum. Posteriorly, **resection of the ribs** close to their vertebral ends alone affords enough space to permit complete elimination of the pus, and if need be **resection of the glands** and other diseased structures.

In *tuberculous mediastinitis* and *tuberculosis of the bronchial glands* the measures indicated for general tuberculosis should invariably be employed, since involvement of structures other than these thoracic glands may exist, though unrecognized. **Out-of-**

door life and **nutritious food** are, therefore, important features of the treatment. As to internal medication, the **iodides** and **creosote carbonate** or **guaiacol** and **arsenic**, in doses adjusted to the age of the patient, are the most effective agents at our disposal. **Tuberculin** is highly spoken of by some clinicians. In a child, $\frac{1}{20000}$ milligram or less, if the reaction be too great, may be given once a week hypodermically, or tried first by the mouth, various authors having found it active when administered in this manner. The bovine tuberculin is said to act similarly. Koch's old tuberculin may be used, and the dose gradually increased.

The **X-rays**, employing the Coolidge tube, may be used coincidently, with either of the above measures, with considerable advantage. **Heliotherapy** has given good results. **Seair** is of material help in all cases, and may even prove curative if the stay at the seashore is sufficiently prolonged. When rupture of a node threatens, **surgical measures** (see CHEST, SURGERY OF) are indicated.

TUMORS OF THE MEDIASTINUM.

The tumors which may develop in this region are sarcoma, carcinoma, **cysts** (both dermoid and hydatid), **fibroma**, **lipoma**, **teratoma**, **chondroma** and **gumma**. But of these by far the most frequently observed are **sarcoma** and **carcinoma**, the former starting in most instances from a remnant of the thymus gland. All other structures in and about the mediastinum may, however, act as starting point of a growth or act as intermediaries for invasion of its cavities from neighboring organs.

The symptoms depend in great measure upon which of these mediastinal spaces is involved, the attachments of the tumor, the rapidity of its growth and its encroachment upon the adjacent organs. While at first it may awaken no symptoms, these become manifest as soon as any degree of pressure is exerted upon them. Thus as regards the *anterior* mediastinal space, pressure upon arteries may awaken inequality of the radial pulses; on the veins—the most frequent effect—it may cause cyanosis with varicosity of the veins of the chest (see colored plate) and neck, and also edema of the face; if both arteries and veins are compressed, coldness and lividity and swelling or edema of the hands and fingers, and sometimes of the whole arm, may be observed. Hoarseness and aphonia, and inequality of the pupil due to pressure upon the inferior laryngeal, vagus, or sympathetic nerves. Pleurisy and pericarditis, with effusion and even displacement of the heart, may be caused. These signs point to a tumor of the anterior mediastinum. Percussion affords little more than unusual dullness, and auscultation nothing reliable. Eustace Smith's sign—a murmur over the manubrium when the head is thrown backward—is sometimes elicited. A radiograph is often helpful.

When the *posterior* and *middle* mediastinal spaces are the seat of the tumor, the symptoms differ considerably from those described. If the trachea and bronchi are compressed and also the vagus, there are inspiratory dyspnea, which may become distressing, and a paroxysmal cough resembling pertussis, sometimes with

blood-stained expectoration; if the esophagus, dysphagia and nausea, and even vomiting in some cases. Pressure upon the ascending vena cava is not infrequent; edema of the lower extremities of the abdomen; pressure upon the azygos veins may produce ascites, and also pleural effusion.

The physical signs may, in this connection, afford considerable information; they are the same as those produced by mediastinal tuberculous glands (see Diagnosis under the preceding heading). Bronchial breathing may be noted.

As to general symptoms, a slight rise of temperature seldom exceeding 102° F. (39° C.) may occur, but it tends to fluctuate and is sometimes accompanied by sweats. In some cases, on the other hand, hypothermia has been noted, due doubtless to mechanical disturbance of the circulation. At first there is no discomfort in the chest, but pain may appear and become very severe if the neoplasm be of solid texture. In cancerous cases the cervical and axillary glands may be enlarged. The destructive process usually entails cachexia ending in death.

TREATMENT.—The frequency with which growths in this location prove to be gummata or tuberculous lymph-nodes renders a trial of **iodides** and even of the **biniodide of mercury** or **salvarsan**, if a syphilitic history can be obtained, advisable. **Calcium lactate** may prove beneficial. Apart from these varieties of growth, however, surgical **removal** or the use of **radium** in massive doses (Burnam) are the only procedures that afford hope.

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THYROID GLAND, DISEASES OF.—The most important disorders of the thyroid: goiter, Graves's disease or exophthalmic goiter, and cretinism or myxedematous idiocy, hyperthyroidism, tumors, etc., having already been reviewed, this section will be devoted to the remaining diseases of this organ.

FUNCTIONS.—The functions of the thyroid gland, as I interpret them, having already been described in this work with a summary of the evidence, a brief outline will alone be submitted here: Briefly the thyroid gland carries on, with its glandules, the parathyroids, two important correlated functions. 1. It enhances oxidation by increasing the sensitiveness or inflammability of the phosphorus which all tissue cells, particularly their nuclei, contain, to the action of the oxygen in the blood, its cellular elements and the tissue cells at large. 2. It takes part in the auto-defensive functions of the body in co-operation with its parathyroid glandules by increasing the sensitiveness (as opsonin) of what phosphorus bacteria, their toxins, endotoxins, toxic wastes, etc., may contain, to oxidation by the oxygen present in the blood, its cellular elements and tissue cells.

HYPOTHYROIDIA.

This is a constitutional disease, also known under the terms **hypothyroidism**, **larval myxedema**, **thyroid insufficiency**, due to deficient activity of the thyro-parathyroid apparatus when the secretory activity of the latter is not sufficiently impaired to give rise to the most advanced and progressive type of the disease: myxedema.

SYMPTOMS.—Cases of hypothyroidia, though commonly met in practice, are seldom recognized. These patients usually apply for relief of pain, particularly in the back or in the occipital region, and occasionally for migraine or neuralgia. The "back-

ache" may consist of sacrolumbar pains, of coccygodynia, or in most instances of severe deep-seated discomfort between the shoulder-blades, which rest in bed tends to aggravate rather than to improve. They complain of feeling fatigued, languid, somnolent on rising; while, as the day wears on, their condition improves. Their temperature is low, and they complain of always feeling cold, especially at the extremities. Their hands are flabby, damp; cold chills may even be complained of.

The patient appears older than her age—women constituting a large proportion of these cases. The hair may be prematurely gray, showing a marked tendency to fall in patches from the forehead and median line, which tends to become wider, and from the occiput. This loss, which is attributed by the patient to the headaches, may be such as eventually to cause complete alopecia. In marked cases the hair may be coarse, dry, and brittle, as in the cretin. The eyebrows also show a tendency to fall, but—a characteristic sign of hypothyroidia—the loss is limited to the external or outer ends. This shortening of the eyebrows and the frontal loss of hair denote, jointly, rather marked cases, though the shortened eyebrows are frequently met in the less severe. Pads of fat especially prominent over the clavicles are characteristic of rather marked cases. Such symptoms, which belong to true myxedema, are rarely observed, however, though a waxy hue of the facial skin and puffy lids are not uncommon.

Dyspnea or oppression, due to deficient oxygenation of the blood, is complained of on climbing stairs or

during continued speaking. Palpitations, sometimes of a distressing character and with severe pain, may also occur. The heart is often found dilated with weak systole and occasional murmurs. The blood-pressure is low, from 80 to 110 mm. Hg., and the pulse weak and rapid.

The blood-forming organs being also inadequately nourished, anemia is the rule, the erythrocytes being usually reduced to about 3,000,000, with more or less anisocytosis. The hemoglobin percentage may be considerably lowered.

The teeth, especially the molars, tend to become loose and carious unduly early, owing to the deficient calcium and phosphorus metabolism which deficient thyroparathyroid secretion entails, and need the constant attention of the dentist. They are also exceedingly prone to become tartarous and require frequent cleansing. Where the teeth are neglected, as in the poor, they are rapidly lost, frequent toothache causing them to be drawn. The gums tend to bleed readily when brushed and to recede from the teeth, and are red and swollen unless the toilet of the mouth be carefully attended to.

The deficiency of germicidal activity (phagocytic and humoral) manifesting itself where protection is usually quite active, *i.e.*, along mucous surfaces, the nasopharyngeal mucous membrane is also apt to be congested through the local accumulation of germs, the tonsils showing, for the same reason, a predilection to acute inflammation. The nasal mucosa is often found turgescient, owing to passive congestion of the underlying tissues. This gives the voice a nasal "twang," but it may also be husky or

otherwise modified or veiled, through infiltration of the laryngeal mucosa.

Constipation due to deficient peristalsis is the rule, and it is often sufficiently obstinate to necessitate constant purgation—which tends to increase the intestinal torpor. Fecal impaction is not uncommon. The liver is passively congested and enlarged—a fact due to the low general vascular tension, which explains also the presence of varicose veins, varicocoele, and kindred vascular disorders frequently observed in these cases.

Flat-foot is sometimes observed, a condition due to relaxation of the interosseous muscular and ligamentous supports; fetid hyperidrosis is also marked in some cases. The osseous framework is often defective, "pigeon-breasts," narrow chests, and a predisposition to caries being common.

The organs of generation are often the seat of functional disorders. The uterus is often found retroflexed. Impotence or loss of sexual desire is common. Amenorrhea is frequent, but metrorrhagia may also occur, owing to the low vascular tone, particularly of the arterioles. During lactation the pallor tends to increase, and edema, especially of the ankles, anemia, lassitude, and intellectual torpor may intervene and last until the infant is weaned.

Hallucinations of sight—as of small animals running across the room—and hearing, rumbling noises or running water, and various forms of tinnitus may occur. Melancholia or, at least, an uncontrollable sadness, due to deficient nutrition of the cerebrum, is often witnessed in severe cases, especially during menopause. The mind, even in the milder cases, is usually obtuse. In predisposed subjects,

hypothyroidia increases the chances of insanity.

DIAGNOSIS.—The thyroid affords very little information under physical examination in these cases. One lobe may feel smaller than the other when, on the patient being asked to swallow, the organ is raised under the palpating fingers; it may seem unusually small, and the neck unusually flat; but, again, it may appear enlarged.

The differential diagnosis of hypothyroidia introduces various commonplace disorders in which drugs are sometimes found to fail. Any rebellious case of *rheumatism, neuralgia, coccygodynia, anemia, a functional heart disorder, constipation, hepatic congestion* and adynamic disorders, including the *mental torpor* of many *backward children*—may thus have, as an underlying cause, insufficient power to react against their causative poisons owing to insufficiency of the thyroid apparatus.

ETIOLOGY.—Hypothyroidia may be hereditary or acquired. The most important *hereditary* causes which entail defective development, morphological and secretory, are syphilis, alcoholism, and the gouty diathesis. Even far back in the parental lines on either side, these, from my viewpoint, transmit their influence through the intermediary of the ductless glands, especially the thyroid, adrenals, and pituitary body, which, jointly carry on oxidation and metabolism and thus constitute, so to say, the tripod of the vital process.

The *acquired* form is often due to conditions which weaken organically or functionally the secretory activity of the thyroid apparatus. The repetition of pregnancy too many times

may not only cause recurrence of hypothyroidia by exhausting the thyroid apparatus, but it may likewise do so in a woman previously free of any disorder of the ductless glands. Prolonged lactation acts in a similar way, the maternal milk serving to protect the nursling against infection. Infectious diseases, especially those of childhood, including the milder ones, measles and mumps, and likewise variola and typhoid, may also produce hypothyroidia by causing interstitial and parenchymatous lesions, which ultimately lead to sclerosis and atrophy. The resulting phenomena are proportionate, of course, with the degree to which the functions of the thyroid are inhibited. They may appear in the midst of the disease, the child failing thereafter to grow physically and mentally and becoming flabby and pale, while showing the typical symptoms of functional hypothyroidia—if not its more advanced stage, cretinoid infantilism. Traumatism of the thyroid may also produce it.

PATHOGENESIS.—At the present time little or no effort is made by writers to explain the manner in which thyroid insufficiency brings about its characteristic symptoms. The functions I have attributed to the thyroid and to the adrenals enable us to do otherwise. With these functions in abeyance or depressed, we have to deal with three essential morbid factors: 1. Deficient tissue oxidation, the rate of metabolism and nutrition in all tissues, particularly those rich in phosphorus, such as the nervous system, cellular nuclei, etc., being retarded. 2. Deficient breaking down of waste products, fats, etc. (slowed metabolism entailing defi-

cient catabolism), with accumulation of fat, detritus, wastes, etc., in the blood and tissues as a result. 3. Deficient resistance of the body to infection and intoxication, owing to insufficient production of opsonin (the thyroparathyroid secretion) and of the other antitoxic and germicidal blood constituents and phagocytic cells, as a result of the slowed metabolism in all organs producing them.

TREATMENT.—Small doses of an American preparation of **desiccated thyroid**, which contains 5 grains of sheep's gland, cause gradual disappearance of the morbid phenomena, while large doses may aggravate them. One grain (0.066 Gm.) during meals is sufficient to begin with in an adult. This may be gradually increased until 2-grain (0.132 Gm.) doses are given if need be. Patients seldom stand larger doses well, and these are only warranted when the prolonged use of the smaller dose fails to improve the patient. Often when improvement is not noticed the fault lies with the preparation administered; a change should then be made. In mild cases one-half of the above doses, or even less, often suffice. One gram of English desiccated thyroid (B. W. & Co.) contains but 1 grain (0.066 Gm.) of the gland proper, and is admirably suited for the use of small doses. Often, fractional doses are more effective than the larger.

When the anemia is profound, the effects of treatment are enhanced by giving **desiccated adrenal gland**, 2 grains (0.132 Gm.), and a small dose of iron, 1 grain (0.066 Gm.) of **Blaud's pill**, with each dose of thyroid. Such a small dose of iron does not increase constipation, and contributes to the

rapid building up of the hemoglobin molecule. The three agents can be given in a capsule. The constipation should receive careful attention. **Saline purgatives** or high injections of **saline solution** two or three times a week are sometimes necessary in severe cases to evacuate completely the lower bowel. This measure may be resorted to the first three or four weeks if needed, and replaced by **glycerin suppositories** until a free motion occurs daily. Usually the fourth week of thyroid treatment is attended by considerable progress in this and all other directions.

MYXEDEMA OR PROGRESSIVE HYPOTHYROIDIA.

DEFINITION.—This disease is the maximum expression of hypothyroidia, as it develops after the process of body growth has been accomplished, *i.e.*, in the adult. When it occurs during childhood or adolescence, it stunts growth of body and mind and is then known as **CRETINISM**. (See page 668 in the seventh volume.)

SYMPTOMS.—The symptoms of myxedema are those of hypothyroidia, but considerably intensified and ending in death when left untreated. The patients suffer almost continuously from cold; their temperature, both oral and rectal, being always subnormal—as low as 93° F. in some instances—unless some fever be present. The least exposure to cold causes the lips, nose, ears, and fingertips to become cyanotic. The extremities are, as a rule, cold and often purple or livid.

The pre-eminent symptom of the disease, however, is a peculiar edema of the skin and mucous membranes. This phenomenon, which led Ord to

designate it "myxedema," is a "jelly-like swelling," as he termed it, which causes the body, particularly the face and suprascapular regions—commonly the seat of cushions or pads—to become irregularly swollen. The infiltrated tissues are elastic, firm, and resistant, but do not pit on pressure, as in true edema, though they vibrate under lateral stroking. The skin is yellowish or wax-like, a circumscribed patch of redness being present, as a rule, below each cheekbone. It is also dry, rough, and scaly, though that of the face may be relatively smooth, and may desquamate in flakes or in the form of a fine powder. Patches of pigmentation varying from yellowish brown to the actual bronzing of Addison's disease may occur. The hair also undergoes changes; it becomes coarse, lusterless, and breaks easily. It is gradually lost, falling out in patches, at first where the traction attending the use of the comb is greatest, *i.e.*, where the hair is parted, the brow, and the occiput. The lids droop over the eyeballs—though exophthalmos may occur, due to primary exophthalmic goiter—causing the patient to appear sleepy, while an effort to raise the upper lid is manifested by elevation of the eyeballs. There is usually considerable lachrymation, due to glandular leakage.

The mucous membranes being involved, as is the skin, those of the mouth and nasopharyngeal cavities appear pale and tumefied. The teeth tend to decay, and may become black within a comparatively short period, owing mainly to deficient calcium metabolism, or readily break off and fall out. This is greatly aggravated by the recession of the gums and the

readiness with which these structures tend to ulcerate and bleed. Stubborn stomatitis, with free salivation, dribbling from the corners of the mouth, and erosions of the buccal, pharyngeal, and laryngotracheal membrane, may appear.

The tumefaction of the oral mucous membrane and of the palate, tongue, and lips renders enunciation very imperfect and jerky; this condition being aggravated by the narrowing of the nasopharyngeal lumen, it gives what voice there is a "nasal" character. It is also rendered coarse and low, that of a woman being sometimes lowered sufficiently in pitch to recall that of a man. Edema of the larynx is not infrequently a cause of death. In some cases, however, the whole oral cavity is uncomfortably dry. The entire alimentary canal, down to the rectum, is also more or less infiltrated, causing anorexia, gastrointestinal disorders, and constipation, which may alternate with attacks of diarrhea. There is, as a rule, a profound distaste for meat. The patients experience trouble in understanding questions and in expressing their wants and ideas, a fact which often renders them extremely irritable. Mental disorders are frequent in these cases, melancholia and even mania being observed. Total lack of interest in their surroundings, somnolence, and amnesia are common.

Great lassitude with exhaustion upon the slightest exertion is the rule. Some cases are unable to raise the head at all or to stand. Others lapse into paralysis. Fibrillary tremor and muscular quivering are often noticed. Locomotion is tentative, often waddling; missteps are frequent, being produced by a

slight obstacle. The ataxic gait may prevail. Sensation being, as a rule, markedly impaired, while the finger-joints are stiffened, the usefulness of the hands is greatly compromised. Small objects are held with considerable difficulty, and easily dropped, while such diminutive articles as pins, needles, and even small buttons are not felt at all. Tingling, formication, and pruritus are often complained of.

The senses of smell and taste are commonly impaired or perverted, the patient complaining of foul odors, a bitter or acid taste, etc. Vertigo is a relatively frequent symptom. The vision is occasionally dimmed and optic atrophy has been observed. Tinnitus aurium is not uncommon, and the hearing is often impaired.

Hemorrhages from one or more organs are common. Epistaxis, hemoptysis; bleeding at the gums, which may prove severe on extracting a tooth; intestinal, uterine, and even cerebral hemorrhages may occur. Probably the most common symptom of this class, however, is menorrhagia. Post-partum hemorrhages are also common in these cases. The menstruation is irregular, as a rule, and often ceases altogether until appropriate treatment procures recovery.

The urea excretion is diminished in most cases, and markedly so when the disease is advanced. In the latter case, both albuminuria and glycosuria (probably alimentary) may occur, but disappear when the thyroid treatment is instituted. Casts are also found in advanced cases.

Myxedema progresses slowly, a case lasting, as a rule, from six to twenty years, unless the patient is carried off through some intercurrent

trouble, which is often the case. Tuberculosis and pneumonia are the infections to which they seem to be especially vulnerable—owing to the enfeebled condition of their autodefensive resources. Nephritis, pericarditis, and cerebral hemorrhage seem to be next in the order of frequency. Periods of amelioration sometimes occur, but sooner or later the patient relapses into his previous state, and gradually dies of exhaustion.

DIAGNOSIS.—The symptoms are so characteristic that a mistake can hardly be made. The thyroid gland is distinctly reduced in size in about 75 per cent. of the cases of myxedema, its outline being hardly discernible by palpation in some of these. Conversely, some are abnormally large at first, and may then gradually atrophy irregularly, the portion which fails to decrease being resistant to pressure.

ETIOLOGY.—Myxedema occurs about six times in women to once in men, and it may develop at any time of life, though the period between the thirtieth and sixtieth years shows by far the largest proportion of cases. There is a marked familial influence, some families showing several cases. While hypothyroidia, alcoholism, and syphilis are likely to be the predominant parental factors, in true myxedema tuberculosis and neuroses are met with much more frequently in the family antecedents of the patient. The main causes appear to be rapid child-bearing, the menopause, worry, mental shocks, and injuries, especially to the head. Neoplasms, fungi, and entozoa capable of destroying or inhibiting a sufficient area of the gland have also been known to cause it.

PATHOLOGY.—Atrophy, due to the development of fibrous tissue, the

glandular elements of the organ being reduced in proportion, is the predominating lesion in the thyroid. It may follow local inflammatory lesions in connection with acute articular rheumatism, erysipelas, syphilis, actinomycosis, cancer, an acute thyroiditis, local injuries, etc., which serve to destroy a part of the glandular parenchyma, and annul in proportion its secretory functions. Excessive child-bearing, shock, and the menopause can hardly be regarded as causes of an inflammatory process, however, and it is probable that we are dealing, in this connection, rather with functional exhaustion of the organ, or with an endarteritis or periarteritis of its vascular supply.

TREATMENT.—The curative effect of **thyroid gland** in myxedema was discovered by Murray, but here, as in the milder hypothyroidia, large doses should not be used. One grain (0.066 Gm.) of the **desiccated thyroid** (American preparation), three times daily, suffices to begin with; this dose may be gradually increased $\frac{1}{2}$ grain (0.033 Gm.) until 2 grains (0.132 Gm.) are given at each meal, and until the temperature is raised to normal. If this is exceeded the dose should be reduced to $1\frac{1}{2}$ grains (0.099 Gm.) or less. The pulse should also be watched, an increase of fifteen beats indicating the need of reducing the dose. The tolerance of each case should be carefully studied. The patient should spend his time in an arm-chair during the day, at first, if possible, in the open air, and begin to walk around only when his temperature and pulse become normal. Violent exercise may prove fatal. The effect of the remedy is to cause gradual disappearance of all the morbid

symptoms, but if its use is discontinued they as surely return. Two grains (0.132 Gm.) daily suffice, however, to perpetuate the recovery in most instances.

When the asthenia is marked and the heart, as is usually the case under these conditions, is considerably dilated, a small dose of **digitalin**, $\frac{1}{20}$ grain (0.0033 Gm.), three times daily, or the desiccated **suprarenal gland** of the U. S. P., or, better, the **pituitary gland**, 1 grain (0.06 Gm.) during meals, greatly hastens the curative process.

Grafting of thyroid tissue is now used successfully to prevent the need of constantly taking thyroid gland. The conditions for success according to Christiani, of Geneva, are: that only normal and living tissues be used; that the grafts be small (about the size of a grain of wheat), but very numerous; that they be inserted in very vascular subcutaneous cellular tissue, and that only human thyroid be employed. This makes it possible to obtain small grafts from a removed goiter containing areas of normal tissue, and to transplant them into the cretinous subject. The tissue can be kept alive an hour in physiological saline solution. A very sharp instrument should be used to cut the grafts to avoid crushing them. They are then introduced *in situ*, where they gain a perfect foothold, becoming perfect thyroid parenchyma. Christiani obtained distinct improvement in 60 per cent. of his cases, which included myxedema, cretinism, dwarfism, etc., remarkable results in 34 per cent., and no result in 6 per cent. The most striking results were in the various types of cretinism, *i.e.*, infantile myxedema.

SURGICAL DISORDERS OF THE THYROID APPARATUS.

INJURIES.—When bacteria invade the gland a true **acute thyroiditis** (*q. v.*, p. 46, fifth volume) occurs; complications of a serious nature may follow, the gland having been in some instances converted into an abscess cavity or into a fibrous mass devoid of functions. A destructive injury may thus initiate cretinism in children and myxedema in adults.

In **wounds of the thyroid**, inflammation and pus formation occurs only when the solution of continuity is small and infection occurs. If the wound is of medium size or large, copious hemorrhage (sometimes very difficult to arrest) follows, and the exposed tissues are cleared of foreign materials under **strict asepsis**, they may heal by first intention.

A **chronic thyroiditis** may follow the acute type, however, either through perpetuation of the infection in some small portion of the gland or the formation of a sinus which fails to heal. In the majority of instances, it occurs concomitantly with chronic processes, such as **sypilis**, **tuberculosis** (especially the miliary form), **echinococcus cysts**, **actinomycosis**, etc. The prognosis in these cases is less favorable than in the acute form, since more or less impairment of the functions of the organ follows the destructive action of the abscess upon the glandular tissues and the resulting fibrous induration. Both the acute and chronic types are prominent causes of hypothyroidia with its long train of morbid results.

The formation of a **thyroid abscess** causes the course of the process to be more protracted. As a rule, the glandular mass is studded with nu-

merous purulent foci, which, if close one to the other, tend to run together. Each abscess tends to break through the adjacent soft tissues, including the skin. The trachea and esophagus may therefore be invaded by a purulent stream when rupture occurs. Metastatic abscesses may also appear in the cervical cellular tissue. When spontaneous rupture occurs through the skin, or when the abscess is surgically evacuated, the inflammatory process recedes rapidly. When, however, it is left to itself, the purulent infiltration of surrounding parts may give rise to serious complications, by involving, besides the trachea and esophagus, referred to above, the mediastinum, the pleura, and the lungs proper, causing septic pneumonia, and also the large vessels of the neck and chest and thus causing pyemia. Thyroid abscesses bleed readily and are sometimes the source of severe capillary hemorrhages.

TREATMENT.—The treatment of wounds of the thyroid is subject to the rules that prevail elsewhere, but conservation of normal tissues should be the aim, even in arresting hemorrhage; **ligatures** and forceps in fact will tear through if attached to its parenchyma; hence they should be confined to vessels and the framework and skin, using **cautery**, **cold**, **astringents** or other familiar measures, if **suture ligatures** or **purse-string sutures** fail to hold.

Where no solution of continuity exists and an *abscess* forms, surgical measures may become necessary. According to Kocher: "The presence of pus is difficult to demonstrate and premature incision must be avoided. If necessary, the gland itself should be exposed. If incision of the abscess

is not followed by rapid recovery, the presence of multiple abscesses should be suspected. Fistula points to extensive necrosis. In such a case the affected half of the gland must be excised. Partial thyroidectomy may also be considered in cases of thyroiditis that have become chronic and in chemicotoxic thyroiditis." In the *chronic thyroiditis* attended by hypothyroidia, **thyroid gland** should be given, and the actually diseased part removed surgically, especially if dyspnea is present. The chronic processes due to *syphilis*, *tuberculosis*, *coccinococcus cysts*, and *actinomycosis* should be treated by the measures indicated in those conditions.

SURGERY OF THE THYROID.

Of the operations on the thyroid and parathyroids those performed for goiter are the most important.

INDICATIONS.—In simple goiter surgical treatment is occasionally demanded: (1) owing to the disfigurement, where the swelling is large; (2) because of symptoms due to pressure on the trachea, esophagus, larynx, or other structures in the neck or upper part of the thorax; (3) when enlargement of the goiter is rapid and a malignant nature is suspected; (4) when symptoms of hyperthyroidism appear; (5) when infection of the goiter occurs. Many patients come to the surgeon for cosmetic reasons alone. The risk attending operation in simple goiter being slight under proper precautions, radical treatment, *provided medical measures have proven ineffectual*, may be looked upon with favor in cases requesting it,—especially since a considerable proportion of simple goiters may subsequently undergo changes resulting in injury to the heart, kidneys, and liver, and possibly become cancerous in later life.

Goiters should be operated on when they are nodular, cystic, or beginning to adhere to neighboring structures, especially in adults. Removal of both lobes of the thyroid is, however, to be avoided in non-

malignant goiters. If both are enlarged, **unilateral removal** is indicated, the lobe which is the larger and extends lower and more deeply into the neck being the one to be removed. At times this deeper lobe is the larger of the two; it should, nevertheless, be the one to be selected for removal. Where the trachea is displaced, that lobe which causes the distortion should be removed. In adenoma or cystic goiters, Socin's operation, **intraglandular enucleation**, may be resorted to.

In diffuse colloid and general adenomatous goiter, the **removal of one lobe and of the isthmus** is generally the procedure of choice, though in some instances **removal of a portion of each lobe**, as advised and practised by Mikulicz, is required. After the unilateral operation the remaining lobe generally undergoes later a reduction in size. Since, moreover, the extirpated lobe is that which is the most diseased, or exclusively diseased, the greater part of the enlargement can generally be removed without serious reduction of the properly functioning parenchyma.

In rapidly growing parenchymatous goiter in young individuals **arterial ligation** has been advised for the purpose of causing atrophy of the goiter tissue.

Encapsulated thyroid tumors may be removed by perforation of the gland substance and enucleation with the finger or a blunt instrument. This is generally the case in the largest substernal goiters. Encapsulated thyroid adenomata are apt to become cystic. **Enucleation** is, here again, the procedure of choice, tapping or injection, which might suggest themselves as simpler expedients, being inadvisable.

Tapping may, however, be resorted to in the course of removal of a cystic substernal goiter, to facilitate its extraction from beneath the sternum. Even in freely movable goiters, provided they can be pushed down behind the sternum or clavicle, removal is considered advisable, as a prophylactic measure.

In large adenomata in which there is only a thin layer of thyroid tissue over an extensive area of the tumor **resection-enucleation** may be carried out, the portion of thyroid tissue over the tumor being left attached to and removed with it,

and the cut edges of the gland then united with sutures.

OPERATIVE PRECAUTIONS.—In operating for goiter or any other tumor of the thyroid, it should be borne in mind that the internal jugular vein may be found lying on the goiter, and that the recurrent laryngeal nerve is very close to the thyroid artery on the right, passing either under or over it, being deeper and against the esophagus on the left side. The proximity of this nerve to the goiter on both sides exposes it greatly not only to operative injury but also to pressure by the growth, with paresis of one or both vocal cords as result. To avoid, therefore, having the operative procedure incriminated for any laryngeal motor disorder subsequently discovered, the operator should always have a competent laryngologist examine the larynx. This will aid also in deciding whether a general anesthetic can be used; for if there is paresis of the abductors, a tracheal distortion or contraction of the tracheal lumen from any cause capable of causing dyspnea, general anesthesia is contraindicated. Local anesthesia plus scopolamine-morphine anesthesia (*q. v.*) should be employed. As shown by several instances, sudden death may occur during the operation: from general anesthesia, closure of the glottis, pressure upon the trachea, or bending or collapse of the latter when the goiter is raised, irritation of the laryngeal nerves, reflex cardiac arrest, air-embolism, and hemorrhage.

Another cause of death should be guarded against, viz., **acute thyroidism**, a term given to a condition which may appear at any time within two days after the operation and sometimes almost immediately after it, and consists of intense dyspnea, a very rapid pulse, high peripheral temperature, which then falls rapidly to subnormal with death in a few hours. This condition has been attributed, as its name indicates, to the colloid freed by thyroid as it is being enucleated, which is thought to be absorbed by the exposed tissues, and to a toxic action of this colloid—the so-called **thyrotoxis**.

[This explanation, based on a pure assumption, diverts the operator's attention from the true condition present, *profound shock*. It has been my good fortune to

save life when called in after the surgeon with the means generally recommended: **avoiding colloid leakage; adrenalin solution applications, cauterizing the stump or suturing the capsule over it, drainage, etc.** had failed to arrest the lethal trend. Almost immediate recovery was obtained, when deep shock (due from my viewpoint to a temporary arrest of adrenal functions owing to loss of the stimulus the adrenals receive from the thyroid hormone) was accepted as cause, and **adrenalin in saline solution** injected intravenously. S.]

The **parathyroids** are important organs in this connection. Gley showed removal of these small organs causes tetany. Hence the fact that the *parathyroids should always be respected* in all operations on the thyroid. They are usually avoided by leaving *in situ* the posterior portion of its capsule, behind which they lie. They are quite small, only about the size of small flattened peas or beans (almost 7 mm. in length by 4 in breadth and 2 mm. in thickness). In the thyroid proper they will be found to be as it were independent, being separated from the thyroid parenchyma by a capsule. If one is accidentally removed it should at once be returned to the capsule of the thyroid lobe left *in situ*, but tetany fails to develop as a rule, if two uninjured parathyroids remain, unless the patient eats much meat.

Should **parathyroid tetany** develop, **parathyroid grafts** (see vol. i, p. 737) should be implanted as soon as possible, but in the mean time, as advised by C. H. Mayo, the **parathyroid serum** of Beebe and Berkeley, should be injected and a 5 per cent. solution of **calcium lactate** given orally, to prevent the attacks of tetany, which, untreated, may cause death. (See also TETANY, p. 628, vol. iii.)

Operative Technique.—According to C. H. Mayo, experience in 5000 operations has shown that the best exposure to be obtained is through a transverse incision low in the neck, the skin and platysma being turned together each way from the incision. Should further exposure be necessary, the sternohyoid may be sectioned high in the exposed area to prevent movement of the cutaneous scar and preserve a working muscle. In simple goiters it is best to extirpate a greatly enlarged

lobe. If both lobes are symmetrically enlarged, division of the isthmus with double resection of the gland is indicated for the best cosmetic results. Midline encapsulated adenomas should be enucleated with division of the isthmus. Lateral encapsulated adenomas may be enucleated or the whole lobe extirpated.

Recent experience has increased the frequency with which a portion of each lateral lobe, rather than the whole of one lobe, is removed. In 45 per cent. of non-toxic goiters dealt with at the Mayo Clinic the enlargement proved to be due to multiple adenomata of various types, seldom confined to a single lobe of the thyroid. Thus in many instances, "**double resection**" is the procedure actually carried out, the posterior portion of each lobe being, however, left *in situ*. In toxic goiter patients Willard Bartlett (1917) resorts to a bilateral operation removing most of the gland tissue on both sides—**subtotal thyroidectomy**. To enable lady patients to conceal the scar with a chain, string of beads, or ribbon, this surgeon passes a chain about the neck with the patient in the usual erect posture and marks out the incision along it in advance.

In Balfour's technique, the isthmus is first divided, and a series of artery clamps placed on the larger vessels in the capsule. The lobe to be operated on is then encircled with an incision through the capsule just anterior to the clamps, and the gland resection made by wedging out the anterior part of the lobe. A continuous mattress suture of catgut is then introduced behind the line of forceps, controlling bleeding and obliterating the cavity in the center of the lobe. Returning in the opposite direction, the same suture catches the edges of the capsule and rolls them together into the semblance of a normal thyroid lobe. The opposite lobe is then similarly dealt with. Pool (1917) in many cases uses a clamp with long delicate blades instead of the series of artery forceps; the clamp not only controls hemorrhage but also facilitates the resection by lifting up and steadying the thyroid lobe. Bartlett closes the skin incision with No. 0000 Chinese silk on a No. 12 non-cutting cambric needle. According to Miles F. Porter (1919) the best re-

sults are secured by closure with subcuticular sutures, supplemented by adhesive plaster, if necessary, to perfect the coaptation.

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THYROID THERAPY. See
ANIMAL EXTRACTS; THYROID GLAND.

THYROIDISM. See ANIMAL
EXTRACTS; THYROID GLAND.

THYROIDITIS. See GOITER.

THYROTOMY. See LARYNX,
DISEASES AND SURGERY OF.

TIC DOULOUREUX. See
NERVES, PERIPHERAL, DISEASES OF.

TINEA. See PARASITES, DISEASES
DUE TO.

**TINEA FAVOSA, TONSU-
RANS, TRICHOPHYTINA.** See
HAIR, DISEASES OF.

TINEA NODOSA. See PIEDRA.

TINNITUS AURIUM. See IN-
TERNAL EAR, DISORDERS OF.

TOBACCO.—*Tabacum* (tobacco, leaf tobacco) is the commercial dried leaves of *Nicotiana tabacum* (fam., Solanaceae). Tobacco has been official in most pharmacopœias, but the leading ones have discarded it. For commercial purposes the petiole and midrib are removed, and are known as tobacco-stems, which are largely employed as an insecticide, especially by florists. The plant is a tall, stout, glandular, hairy herb, with large, long leaves, annual or perennial, according to the region in which it grows. The leaves are gathered and hung up, for several weeks, to dry or "cure," with the tops downward. After curing, the leaves are removed from the stems, assorted as to size and quality, gathered into small bundles (hands), and packed for marketing. Tobacco contains, in addition to a number of salts, resin, gum, sugar, etc., 1 to 8 per cent. of the poison, nicotine, the amount of which determines the strength of tobacco, and nicotianin, or tobacco-camphor, which is the source of the aroma

or flavor. While the toxic action of tobacco-smoke was thought to be due chiefly to nicotine, certain oxidation products, as collidine, pyridine, picoline, and other bases of the same series, besides ammonia and traces of ethylamine, must be considered in that connection. When subjected to dry distillation, tobacco yields a brown-black, tar-like liquid of a strong and very characteristic empyreumatic odor, called oil of tobacco. The principal interest of tobacco to the physician centers in its poisonous effects.

PHYSIOLOGICAL ACTION.—Tobacco is a local irritant to mucous membranes, a stimulant to the secretions, and when swallowed is a laxative or purge, depending on the amount ingested. Experiments with nicotine have shown that it causes a brief primary stimulation of the spinal cord, medullary centers, and, in particular, the ganglia of the sympathetic and vagosacral autonomic systems, followed by marked depression of the same nerve-cells. These actions account for the rise in blood-pressure through vasoconstriction, the glandular stimulation, and the excitation of involuntary muscle tissues, including those of the alimentary tract and bladder, which small amounts of the drug customarily produce. After larger amounts, the opposite effects prevail. Gannon, Aub, and Binger have shown nicotine capable of exciting increased activity of the adrenals.

ACUTE POISONING.—In overdose, or in those unaccustomed to its use, it produces nausea and vomiting, quick, deep, and then labored respiration, great muscular relaxation, giddiness, mental confusion, restlessness, feeble circulation, general depression, and, occasionally, clonic convulsions (apparently of spinal origin), followed by complete loss of reflexes, and death from respiratory paralysis. Many of the fatal cases have followed the use of tobacco as an external antiseptic application, or as a parasitocidal enema, rapid absorption of the nicotine following.

CHRONIC POISONING.—A long-continued heavy use of tobacco produces chronic inflammation of the upper air-passages (nasopharyngitis), indigestion, anorexia, cardiac irregularity and palpi-
tation.

tion (tobacco-heart), deafness, headache, giddiness, tremors, and other nervous symptoms due to congestion of the brain, spinal cord, and peripheral nerves. The eye loses its vision for colors, and complete blindness may result from degeneration of the optic nerve. The testicles atrophy and become discolored, and the ovary of the female habitué shrivels into a small kernel, hard and yellow (fibrous degeneration). Libido and virility are markedly diminished. It is believed that, owing to the frequent increase of blood-pressure, it causes arteriosclerosis, a common result of long-continued abuse of tobacco.

Most of the evil effects from tobacco abuse, unless very pronounced, disappear upon removal of the drug, fresh air and exercise, baths, bromides and digitalis to slow and strengthen the irritable heart, and similar hygienic and symptomatic measures. It is claimed that the blood-pressure is increased, and that arteriosclerosis is a common result of long-continued abuse of tobacco.

TREATMENT OF ACUTE POISONING.—When poisoning has occurred from the ingestion of a poisonous dose, and there is not free emesis, **wash out the stomach** repeatedly, using an abundance of warm water, or give an emetic of **mustard** (4 drams in 1 to 4 ounces—15 Gm. in 30 to 120 c.c.—of water), **zinc sulphate** (20 grains in 1 ounce—1.3 Gm. in 30 c.c.—of water), or **apomorphine hydrochloride** hypodermically (2 to 4 minims—.012 to 0.25 c.c.—of a 2 per cent. solution); repeating every fifteen minutes till effective. To antidote the residual poison give **tannic acid** (30 grains in 1 ounce—2 Gm. in 30 c.c.—of water) before vomiting has ceased, or before last siphoning of stomach. If tannic acid is not at hand, give **iodine** (1 to 2 grains—0.06 to 0.12 Gm.)—with **potassium iodide** (5 to 10 grains—.3 to 0.6 Gm.) in water (1 to 4 ounces—30 to 120 c.c.); **strong tea** or **decoction of oak-bark** (4 drams in 4 ounces—15 Gm. in 120 c.c.—of water) may be used. To eliminate the absorbed poison give **water** freely and **spirit of nitrous ether** (1 dram—4 c.c.). To counteract the dangerous symptoms, give **strychnine nitrate** hypodermically ($\frac{1}{32}$

grain—0.0024 Gm.), or administer **tincture of nux vomica** (30 minims—2 c.c.) by mouth to stimulate respiration and support the heart. Stimulate with **brandy** or **whisky** (2 to 4 drams—4 to 8 c.c.) per dose, or **spirit of chloroform** (20 to 40 minims—1.3 to 2.6 c.c.). The patient should be kept in the **recumbent position** with **warm applications to the chest and extremities**, and **cold applications to the head**. W.

TOE, HAMMER.—See ORTHOPEDIC SURGERY.

TOE-NAIL, INGROWING.
See NAILS, DISEASES AND INJURY OF.

TONGUE, DISEASES OF.— TONGUE-TIE, OR ANKYLOGLOSSIA.

—This condition is due to an abnormally short frenum linguae, to which were formerly attributed many of the disorders of infancy. It is only when it is sufficiently short to cause the tongue to be held behind the incisors that a frenum can prevent suckling or interfere with articulation. In most cases, the trouble disappears as the child grows, persistent tongue-tie being extremely rare.

Undue elongation of the frenum may produce similar symptoms, especially when its upper insertion is unusually near the tip.

Treatment.—Although division of the frenum presents no difficulty, it is **practically never indicated**. Again, it may become dangerous if the presence of the ranine arteries is not borne in mind, fatal hemorrhage having occurred. The tissues should therefore be carefully examined and the portion cut be isolated from any vessel encountered. Blunt-pointed scissors are used, after anesthetizing the parts with a 10 per cent. solution of **cocaine**, applied with a camel's-hair pencil. The mouth should be kept scrupulously clean.

When the frenum is excessively long, reaching sometimes to the point of the tongue and impeding its movements, simple section is not sufficient; **excision** must be resorted to.

LINGUAL PAPILLITIS.—This is an inflammation of the papillæ of the tip of the tongue, sometimes ulcerative, often met with in gastric disorders. Its only symp-

tom is a burning or lancinating pain on the anterior two-thirds of the organ, with greater intensity on its tip and borders. The pain, often recurring at intervals in the form of neuralgic attacks, is aggravated by the ingestion of food—solid or liquid, excepting of milk. No other trouble, either of general and special sensibility or of the salivary secretion, is observable. Examination with the naked eye does not reveal any noticeable alteration, but examination with the magnifying-glass shows, in several places, and chiefly on the borders and tip of the tongue, little red points, ulcerated and very tender, the number of which is greater in proportion as the pain is more violent. The lesions are evidently in the sensory terminals of the lingual mucosa.

Treatment.—Touching (with the aid of the magnifying-glass) each ulcerated tip with pure **silver nitrate** fused on the end of a probe or **galvanocautery**, a few points being cauterized at each sitting, is the only efficient local measure, besides treatment of the causal gastric disorder.

PARENCHYMATOUS GLOSSITIS.—Inflammation of the tongue is usually due to traumatism. It may be caused by slight injuries inflicted during mastication, or to carious teeth, scalds, bites, incised or punctured wounds, laceration, etc. Inflammation of the tongue probably never occurs without the introduction in its parenchyma of some pyrogenic organism.

Symptoms.—Swelling of the organ, sometimes causing it to protrude from the mouth, is usually the first symptom. Severe pain follows and deglutition is impeded. When the swelling involves the lymphatic elements in the posterior portion of the tongue, dyspnea may appear, owing to pressure on the epiglottis. Stomatitis and pytalism are more or less marked. The breath is usually fetid, owing to a thick, yellowish coating on the lingual surface, which may also present striae of ulceration. There may be considerable fever. The symptoms become aggravated up to the third or fourth day, when there is a lull, followed by gradual improvement. Occasionally an abscess forms deep in the organ, as a rule, close to the periphery. Gangrene sometimes occurs; rarely, but one side is affected.

Treatment.—The tongue should be kept moist and clean, by means of a mucilaginous solution containing 10 grains (0.65 Gm.) of **boric acid** to the ounce (30 Gm.). This can best be done by the patient himself with a cotton swab. A 25 per cent. solution of **argyrol** is effective for superficial ulcerations. **Continuous cold compresses** or, if the mouth can be closed, small pieces of **cracked ice** are grateful. When there is great infiltration, **scarifications** with a thin knife (under antiseptic precautions) afford marked relief if a couple of ounces at least of blood are drawn. Severe pain may be counteracted by painting the organ occasionally with a 4 per cent. **solution of cocaine**. When an abscess forms, **evacuation of the pus** by incision soon reduces the glossitis.

When feeding becomes difficult a **catheter** introduced on the side of the tongue into the pyriform sinus—i.e., alongside the larynx—adequately serves for the giving of **liquid food**. **Rectal alimentation** is sometimes necessary, and occasionally **tracheotomy** to avoid asphyxia. **Saline purges** early in the case tend to shorten the duration of the glossitis.

CHRONIC GLOSSITIS.—This condition, also known as **glossitis desiccans**, is, in many cases, attributed to syphilis, when in truth it is but the result of tobacco irritation, or, as shown by Brocq, due to gastric affections in rheumatic subjects. Strong alcoholic drinks are occasionally the cause.

Symptoms.—The tongue is red and sensitive, especially near the edges, and oval grayish patches resembling those of syphilis replace papillae or epithelial cells which have yielded to the superficial ulcerative process. The resemblance to syphilis is accentuated by deep furrows, which tend to separate the tongue into island-like, lobulated surfaces. A foul breath is often present, especially in drunkards. The history and the results of treatment alone facilitate diagnosis.

Treatment.—Correction of dietetic errors is of prime importance. If syphilis is suspected, a course of **potassium iodide**, freely diluted with water, will do no harm if no luetic trouble is present. Applications to the furrows of **silver nitrate** solution, 20 grains (1.3 Gm.) to the ounce (30

c.c.), with a camel's-hair pencil (never the solid stick), or if the tongue is sensitive a 25 per cent. solution of **argyrol**, soon improves them. The oral cavity should be kept scrupulously clean, and washed out three times daily with a **saturated solution** (1 dram—4 Gm.—to the pint—500 Gm.) of **potassium chlorate**. If pain exists, especially after meals, the tongue should be cleansed and a 4 per cent. solution of **cocaine** applied with a cotton pledget to the painful areas.

LEUKOPLAKIA.—This disorder is assimilated by various authors to psoriasis, herpes zoster, etc. While it may affect the entire mouth, it is usually most marked on the tongue, and consists of whitish, opaline patches of cicatricial aspect, which tend to disappear spontaneously and to reappear. It awakens no symptoms other than slight pain at the seat of the lesions, which are, in reality, narrow, minute ulcers. The pain is increased by contact with irritants.

Leukoplakia occupies an important position in diseases of the tongue, since it is thought by many authorities to be a frequent—in at least one-third of the cases—precursor of epitheliomatous cancer of that organ. The lesions usually consist of epithelial thickenings which many assimilate to, or trace to, syphilitic mucous patches (79.85 per cent., Erb; 65 per cent., Neisser). Hence the need, in every instance, of a Wassermann to establish the diagnosis. It has been observed in childhood as a result of hereditary syphilis. Smoking—including the pressure of the pipe-stem—angular tooth-fragments or defective plates have also been incriminated.

Treatment.—A 20 per cent. solution of **potassium iodide** frequently painted on the affected points, according to Rosenberg, has cured stubborn leukoplakia in a few days. Other efficient agents are **X-rays**, and an ointment of **salicylic acid** 5 grains (0.3 Gm.) to the ounce applied several times daily according to Hartzell. A **copper sulphate**, 20 per cent. solution, applied daily over the cleansed tongue, is preferred by some.

The first sign of cancerous change as observed by Parker is cracking in the white covering or its ragged border which exudes blood or serum, a feeling of stiff-

ness in the affected area being also experienced. When such an area becomes indurated to any degree **local excision** should not be delayed. It is the only way to avoid the final evolution of this disease into true epithelioma. Solid silver nitrate should never be used.

ECZEMA OF THE TONGUE.—This condition is characterized by the presence of patches on the tongue, also sometimes on the cheeks and lips, which tend to heal in the center while the border spreads to unite with that of other patches. It is due to desquamation of the epithelium. The peculiar appearance of the organ has caused the disease to be termed also **geographical tongue**, owing to the sinuous outlines of the patches. Some itching and burning are about all the symptoms complained of during the many years the disorder may last. It is often mistaken for syphilitic ulceration, and is due, in most instances, to a gouty diathesis.

Treatment.—The itching and burning is relieved by a 4 per cent. solution of **cocaine** applied with a cotton pledget. The **iodides** or **thyroid gland** and a **meat-free diet** should then be employed for a time to counteract the formation of toxic waste. Locally either a 25 per cent. solution of **argyrol**, a weak solution of **silver nitrate**, or a saturated solution of **potassium chlorate** are efficient measures if used frequently.

ULCERATION OF THE TONGUE.—The tongue frequently becomes the seat of ulcers, benign and malignant, and the recognition of their true identity is frequently of importance. They may be divided into four classes:—

Simple Ulcer.—This usually occurs around the edge of the tongue, and its border may be tumefied and raised, as in epithelioma. In the neighborhood, however, may often be found a carious tooth, or the lesion may be traced to some other form of traumatism. While there is swelling around the base, it is limited in extent and there is no induration such as characterizes cancer.

Upon removal of the cause, and the remedial measures described under Glossitis, it soon disappears.

Syphilitic Ulcer.—These are usually preceded by induration; in cancer this indu-

ration almost always appears *after* the ulcerative process has begun. The ulcer in syphilis is usually located near the tip; a cancerous ulcer is on the side. There are usually two or more gummata; cancerous ulceration is always single. The tongue is often furrowed and fissured in syphilis; never in cancer. There is often a history of syphilis, and test treatment soon establishes the diagnosis.

Tuberculous Ulcer.—This ulcer is single, as in cancer, but there is no induration; though it may, by its color, resemble a gumma, it is often yellow. The base may present minute, yellowish dots, even if the ulcer is grayish white; this is the main habitat of tubercle bacilli, which can often be detected in scrapings. Tuberculous ulcers sometimes heal, leaving a scar; a cancerous ulcer spreads steadily. A tuberculous ulcer usually coexists with tuberculosis in another region, especially the larynx. Lupus rarely, if ever, attacks the tongue primarily.

Cancerous Ulcer.—The ulcer attending cancer, besides the features already noted, is ragged and everted, progresses irregularly in various directions, and is angry-looking. It soon becomes fungous and granular, is covered with an ichorous, fetid liquid, and bleeds upon the least contact: a condition witnessed in no other variety. The neighboring glands soon become enlarged: the only condition in which this also occurs is lupus, but this seldom if ever attacks the tongue primarily. The age of the patient, beyond forty years, at which cancer occurs, is seldom, if ever, that at which lupus is observed.

Treatment.—The treatment is, of course, that of the causative condition, but the local measures are those described under Chronic Glossitis.

TUMORS OF THE TONGUE.—Statistics based upon 13,824 recorded cases of tumor by Roger Williams showed that out of this number 880, or 6.3 per cent., originated in the tongue. Of these, 804 were **epithelioma** (91.3 per cent.), while the remaining forms consisted of **sarcoma** (of which but 33 cases had been reported up to 1910 according to Serafini), **papilloma**, **cystoma**, **fibroma**, **adenoma**, **myxoma**, and **angioma**.

Ranula is a relatively common retention cyst of the sublingual or submaxillary glands; **mucous cysts** originating from the mucous glands of the floor of the mouth on each side of the tongue and also immediately behind the incisors under the frenum, which it raises, are not infrequently taken for more serious growths. This applies also to **thyroglossal** or **thyrolingual cysts**, formed by remnants of the mucous glands of the **thyroglossal sinus** which, in the embryo, passes from the foramen cecum of the tongue to the thyroid isthmus, and also to **sublingual dermoids** formed from remnants of the duct between the foramen cecum and the hyoid bone. All these benign growths rarely attain large size, but at times this is sufficient to interfere with speech and deglutition. **Parasitic cysts**, including echinococci, cysticerci, etc., have also been found, though rarely, in the lingual tissues.

Treatment.—In ranula or any of the mucous cysts, **excision** of the cyst is the most satisfactory procedure. Or an **incision** may be made and the interior is cauterized with **phenic acid**. All other benign growths should be **extirpated** if they cause any discomfort. For the removal of thyroglossal cysts, general anesthesia and preliminary tracheotomy may be required. G. B. New reports 2 cases of lingual lymphangioma cured by **radium**.

CANCER OF THE TONGUE.—As shown above, the variety of cancer most frequently met with here is epithelioma.

Symptoms.—These depend upon the location of the lesion. When it begins far back in the mouth, the submaxillary or posterior sublingual regions become sensitive, and darting pains reaching the ear are complained of. Lobular, movable, hard swellings may perhaps be felt: infiltrated glands. Deglutition soon becomes somewhat impaired, and the tongue is moved with difficulty during articulation. The submaxillary glands have, by this time, probably become fixed and enlarged, and the disease progresses rapidly. Profuse ptyalism is soon followed by the expectoration of foul pus, often tinged with blood—all evidences that ulceration has begun. This exposes the patient to death from hemorrhage, owing to the proximity of the growth to large vessels.

When the growth starts anteriorly, the process may be followed with more precision. A small slit or crease, a minute hypertrophied papilla, or a small warty projection may prove to be the primary focus. The crown of this soon becomes ulcerated and covered with thin scabs, which the patient removes as fast as formed, leaving a bleeding surface. Then gradually develops the typical epitheliomatous ulcer with ragged edges, and a hard, broad, infiltrated base and fungous outgrowths filled with fetid pus, which gives the breath a repulsive odor. As the neoplasm spreads, the suffering of the patient becomes gradually more acute, the tongue is immovable, the submaxillary glands markedly enlarged, and he gradually sinks as a result of starvation and exhaustion, if hemorrhage does not bring on sudden death. When the growth begins anteriorly, the lymphatics are not involved as early, and the chances for a successful operation are consequently greater.

Etiology.—Cancer of the tongue is comparatively rare among women—about 16 per cent. of reported cases. This is, to a certain degree, accounted for by the causative factors, the principal ones being: smoking, jagged teeth, the scars of syphilis, alcoholic drinks, the pressure of a pipe-stem on one spot, traumatism; various disorders of the tongue, especially leucoplakia, etc.; briefly, any condition which tends to cause irritation of circumscribed area of the organ. The promiscuous application of solid nitrate of silver or any kind of caustic is also thought to be a prolific source.

The age of incidence corresponds to that of cancer in other parts of the organism, namely, after 45 years. Occasionally, however, it occurs earlier, but a large proportion of such cases are observed in women. Hereditary predisposition may be traced in many cases.

Prognosis.—Left to itself, lingual epithelioma steadily progresses, and death occurs in from eighteen months to two years after the character of the neoplasm has been recognized. In a series of 69 cases treated by Sachs the average time between the onset and the time the cases presented themselves for treatment was five months. It is probable, therefore,

that two years represent the average duration of life. The prognosis is also greatly influenced by the operation; the more radical this is, the better are the chances, especially if glands are involved. Early involvement of the glands is an unfavorable sign, particularly when the cervical glands behind the angle of the jaw are affected. An operation, if performed when the case is not too far advanced, invariably prolongs life even in cases of recurrence. This is especially evident in private cases. Butlin's percentage of cures in 102 operations was 16 in the hospital group and 26 in private cases. This is due, in his opinion, to the fact that private patients, being better educated, *apply for operation much earlier than do the others*. In the majority of cured cases the disease was situated in the anterior two-thirds of the tongue. But even some of the worst cases may be cured if the disease has not invaded the tonsillar and neighboring regions.

Treatment.—Many methods of removal such as the elastic ligature, the chain or wire écraseur, and the actual cautery, have been tried and ultimately abandoned. **X-rays** may be tried, but the results have been dubious. **Early excision** of the neoplasm with the knife or scissors is the only procedure which has given good results.

Butlin's Technique.—According to Butlin, whose results have been, when compared with those of many other operators, most satisfactory, removal of the entire tongue is not essential to a successful operation. With the cancer, he removes three-fourths of an inch of apparently healthy tissue around it in every direction. When the disease is on the border of the tongue, half the tongue to an inch behind the margin of the disease is excised. Where the disease is near the tip or forepart of the dorsum, the forepart of the tongue is removed. Butlin removes the entire contents of anterior triangle of the neck. He makes a careful dissection of the triangle, to insure that all the connective tissue and glands be taken out in one mass. Search is made between the muscles in front for one or two deeper-seated lymphatic glands, and those in front of the parotid gland and about the angle of the jaw are taken out with the

contents of the triangle. The submental and parotid glands are not so easily and certainly removed *en masse* in this operation as the submaxillary and carotid groups. This is done at a second operation, and not at the time of the excision of the tongue.

If the growth is removed in the *superficial stage*, with a margin of one-half to three-fourths of an inch of healthy tissue, recurrence is practically certain not to take place. In the *diffuse stage* the most important sign is a loss of definite outline of the growth, the margins no longer being hard and well defined. This condition is associated with submucous involvement and bears no relation to size of the growth. Regardless of the extent of the operation—which should be radical and include all muscles—that may be done in this stage, it is impossible safely to give a favorable prognosis. W. Trotter (Lancet, Oct. 24, 1914).

Whitehead's Technique.—Walter Whitehead, after extensive experience, advised the following procedure, which many surgeons now recommend: The patient is placed completely under anesthesia during the first stage of the operation, but afterward only partial insensibility is maintained; the mouth is securely gagged and kept fully open throughout; the head is supported in such a position that, while the best light is secured, the blood tends to gravitate out of the mouth rather than backward into the pharynx. A firm ligature is passed through the tip of the tongue for traction. The first step consists in dividing the reflection of mucous membrane between the tongue and the jaw and the anterior pillars of the fauces. Rapid separation of the anterior portion of the tongue from the floor of the mouth is then made. If possible, the lingual arteries should be secured with Spencer Wells's forceps prior to division. A ligature is passed through the glosso-epiglottidean fold before finally separating the tongue. A mercurial solution should be applied to the floor of the mouth, and the surface painted with an iodoform styptic varnish.

Hemorrhage is one of the most important dangers encountered in amputation of the tongue and subsequently. Whitehead's operation is done with scissors after the lingual artery has been ligated. But if this should give way, the following procedure recommended by Heath arrests the bleeding: The forefinger passed well down beyond the epiglottis is made to hook forward the hyoid bone and drag it up as far as practicable toward the symphysis menti. The effect of this is to stretch the lingual arteries so as to completely control for a time the flow of blood through them.

Kocher's Technique.—Another danger connected with excision of the tongue is septic pneumonia or bronchopneumonia, brought on through infection from the wound. This is prevented to a great degree by Kocher's method of plugging the pharynx with carbolized sponges and iodoform gauze, after tracheotomy had been performed. The trachea is thus totally disconnected from the wound and no pus can enter it. But the **Trendelenburg position** obviates the necessity of this preliminary step, which further weakened the patient.

Kocher's operation is performed as follows: "An incision is made commencing a little below the tip of the ear and extending down the anterior border of the sternomastoid muscle to about its middle, then forward to the body of the hyoid bone and along the anterior belly of the digastric muscle to the jaw. The resulting flap is turned up on the cheek and the lingual artery is ligated as it passes under the hypoglossus muscle. Commencing from behind, all the structures in the submaxillary fossa are removed, viz.: the lymphatic glands, the maxillary and, if necessary, the sublingual glands. The opposite artery is now tied by a separate incision if the whole tongue is to be removed. The mucous membrane along the jaw and the mylohyoid muscle are then divided and the tongue drawn out through the incision and removed with scissors or galvanocautery."

After-treatment.—More than ordinary attention must be given to this. Before, during, and after the operation the mouth should be kept as aseptic as possible by

means of **borax** or **potassium permanganate** solution, 20 grains (1.3 Gm.) to the ounce (30 Gm.) of the former, and 1 grain (0.065 Gm.) to the ounce (30 Gm.) of the latter. After the operation Whitehead washes the parts with a solution of **bichloride of mercury**, dries it thoroughly, then applies an **antiseptic varnish** composed of the ingredients of Friar's balsam, but substituting a saturated solution of **iodoform** in ether. This he found to be more comfortable to the patient than gauze or lint. Some surgeons prefer to **pack the cavity with moist iodoform gauze**—made with glycerin and rosin dissolved in alcohol. Treves, when the oozing has ceased, dusts the mouth with **iodoform**, then every three hours renews this, after carefully spraying the mouth with a solution of **hydrogen peroxide** and another of **phenol**, and mopping the tissues dry.

At first **rectal feeding** is obligatory. After a day or two the patient can usually take liquid food from a feeding cup. As soon as he is able to sit up, the second or third day, he should, as much as possible, hold his head forward and downward so as to prevent gravitation of the discharges into the pharynx and esophagus. But rectal feeding should be continued to sustain the patient's strength.

INJURIES OF THE TONGUE.—Injuries of the tongue are seldom dangerous, though profuse bleeding sometimes ensues. The organ is frequently bitten during falls, trismus, an epileptic attack, etc., and occasionally completely severed. Injuries of external source are infrequent, owing to the protected position of the organ. Foreign bodies are occasionally introduced, and remain in the lingual tissues, giving rise subsequently to an enlargement suggesting a growth.

Treatment.—In slight or moderate traumatism the use of **ice**, **compression**, etc., soon arrests the flow. If this does not succeed, **solution of ferric chloride** or the **cautery** may be tried. Profuse hemorrhage requires **ligation of the cut artery**—probably the **ranine**, easily found usually by raising the tongue. Approximation with **sutures** sometimes suffices even when the hemorrhage is quite severe, but it is usually easier to find and tie the main

bleeding vessel. Sutures should be tied with unusual care, to avoid loosening of the knots by movements of the tongue. Loose pieces heal quickly when carefully adjusted. While the wound is healing, the mouth should be kept as nearly aseptic as possible by means of a saturated solution of **sodium borate**, frequently employed. S.

TONGUE-TIE. See TONGUE, DISEASES OF.

TONSILS. See PHARYNX AND TONSILS, DISEASES OF.

TORTICOLLIS. See MUSCLES, DISEASES OF.

TOXEMIA. See WOUNDS, SEPTIC.

TOXIC FOODS, or PTOMAINE POISONING.

—Poisoning by foods was formerly attributed to *ptomaines*, which are alkaline products of cadaveric decomposition, and to *leucomaines*, also alkaline, but products of metabolism, some of which are toxic. Modern investigations have tended to show, however, that bacterial toxins were the main factors in the morbid process. To these factors must be added infections conveyed to the consumer by foods derived from diseased or contaminated animals, and also certain foods containing alkaloids, metallic poisons, adulterants, etc. The element of sensitization or anaphylaxis has recently been suggested as a possible factor of the morbid process.

MEAT POISONING.—Besides *ptomaines*, i.e., cadaverin, putrescin, sepsin, etc., which may be, when in sufficient quantity, detected by smell and taste, the toxins of various bacteria may render meat toxic irrespective of any change sufficient to offend these senses. The most active of these are the following:—

Bacillus enteritidis. This bacillus, isolated by Gärtner, belongs to the colon group. It is a short, flagellate, and moderately motile rod, the toxin of which is very active, and resistant to heat. In keeping with infections by the typhoid colon group that due to the *B. enteritidis* causes the appearance, in infected individuals, of specific agglutinins in the serum, thus affording an important diagnostic

sign, Widal's reaction is often positive. This form of poisoning is usually due to the ingestion of meat derived from animals slaughtered while ill. Even cooking does not prevent the toxic effects—another distinguishing sign. The meat is usually normal as to color, odor, and flavor. Any meat kept several days or made into some form of sausage is most apt to cause trouble. The introduction of cold storage has greatly increased the number of cases of this form of poisoning; canned meat occasionally gives rise to poisoning from the same cause.

The presence of *B. enteritidis* in vomited matter or stools may be ascertained by planting some of either on malachite-green agar, and by injecting some in mice. The agglutination test referred to above should also be employed.

Bacillus botulinus. This organism, first isolated by Van Ermengen, has been found mainly in hog flesh, particularly in sausages and hams, but also in canned vegetables and fruit. It differs totally from the organisms of the colon group in its mode of action, in that it resembles the tetanus bacillus, being found in the soil and in the feces of animals and growing anaerobically.

Its presence in suspected food may be ascertained by injecting some of the latter into rabbits and guinea-pigs or feeding it to mice. Cultures grown anaerobically, as stated, when one week old and filtered, should prove highly toxic to test animals in which they are injected. Like that of tetanus the toxin of *B. botulinus* is soluble and the effects produced are those of an intoxication and not of infection, the organism being a pure saprophyte which does not multiply to any harmful extent in the body.

Bacillus proteus. This organism isolated by Levy is found to be found in meats, including that of fish, which have undergone putrefaction. It is to its toxin that the morbid symptoms provoked are credited, since uninfected putrid meat and fish, "ripe" or "high" game, are used as steady diet in some countries without harmful effects. It is often present in meat, however, the consumption of which proves harmless. Its pathological effects are not as severe as those of the preceding types

reviewed, and are of shorter duration. Its bacilli are as toxic when dead as when alive, but a moderate heat (60° C.=140° F.) suffices to annul the activity of their toxin.

The presence of *B. proteus* may be determined by culture and by feeding the suspected food to mice, in which it will cause death within 24 hours from gastro-enteritis. The *B. proteus* may be supplanted, however, after a given time by the *Bacillus paratyphosus* referred to below.

Bacteria of Diseased Meat.—The consumption of meat from an animal suffering from specific disease is the cause of the vast majority of cases of poisoning. Not infrequently the flesh from animals which had died of such a disease, even though boiled, in some instances, had been consumed. The multiplication of the specific germ then continued in the meat or in the persons by whom it was eaten. Puerperal or traumatic septicemia and pyemia, peritonitis, enteritis—usually with the *B. enteritidis*, *paratyphosus*, *suipetifer* (hog cholera) as leading pathogenic agents in the latter disease—and anthrax, are the main disorders of animals to which this form of poisoning has been traced. Beef, veal, pork, horse flesh, and fowl, especially when minced or prepared in the form of sausages, owing to thorough dissemination of the germ during the process of chopping, have afforded the largest number of cases. An epidemic of pneumonia which cost 490 deaths in Middlesborough, England, was traced to an imported stock of bacon. A mild form of typhoid fever has also been traced to the *B. paratyphosus*, which differs but slightly in cultural peculiarities from the colon bacillus.

Symptoms.—These vary according to the nature of the pathogenic organism the poisonous meat contains.

If the *B. enteritidis* be the source of the toxin, the symptoms appear rapidly, i.e., within a few hours, and consist of nausea, vomiting, diarrhea, and severe colic, soon followed by marked weakness, sweating, and collapse. Herpetic or urticarial eruptions have been observed. Catarrhal pneumonia and nephritis may occur as sequelæ, but as a rule no complications follow, though convalescence may be

greatly protracted. The mortality does not exceed 5 per cent. The *B. suisepicus* (of swine plague) gives rise to very similar symptoms.

When the *B. botulinus* is the offender the symptoms point to involvement of the nervous system. While gastroabdominal phenomena—nausea, vomiting, and gastric pain—occur, these are followed by disturbances of vision, diplopia, amaurosis, dilatation of the pupil, with loss of reaction to light, ptosis, dysphagia, intense thirst, suffocative coughing, constriction at the throat, aphonia, cardiac disturbances, hypothermia, cold extremities, soon followed in lethal cases by delirium and coma. In favorable cases the latter fail to appear and recovery occurs, though very slowly, extreme prostration sometimes persisting several weeks. The mortality is greater than in the *B. enteritidis* cases.

The *B. proteus* provokes a gastroenteritis, with nausea, vomiting, severe colic, and very fetid diarrhea; also headache, vertigo, and marked weakness,—all of which occur soon after its ingestion with food. These symptoms usually last but a short time, ending, as a rule, in recovery. Cooking tends to destroy the toxin of this germ. Hence the occurrence of toxic phenomena in cases in which raw meat had been consumed.

FISH POISONING.—Some fishes are inherently toxic, either through the presence of a poisonous body in the liver, ovaries, etc., or through their roe or spawn. The liver of the swordfish illustrates the former and the roe of the barbed sturgeon and pike the latter. In Japan and China *fugu-poisoning* is due to a substance in the ovaries and testicles of *Tetrodon* and *Diodon*. The symptoms produced by the latter resemble greatly those of curare poisoning.

Bacteria, as in meat intoxication, account for the majority of cases of fish poisoning, with *B. proteus*, *B. paratyphosus*, and *B. enteritidis* as prominent factors, and *B. botulinus* as an occasional one. The fish may show nothing abnormal when eaten and yet, even though salted, be permeated with bacteria the toxins of which are active, as we have seen after boiling, excepting in the case of *B. proteus*. Pto-

maines, which may be very poisonous, are also found in fish that have undergone decomposition; but these ptomaine-like bodies are more active in the earlier stages of decay than later. Any softness of the flesh or any degree of unpleasant odor should cause any kind of fish to be rejected.

As in meat poisoning the use of diseased fish, especially if eaten raw, transfer to the consumer the pathogenic organisms of that disease. If it is a disorder, septicemia, for example, which is communicable, toxic phenomena will appear. Canned fish, salmon in particular, has caused poisoning, owing, according to Vaughan, to a micrococcus developed therein. The tin of the can and metallic poisons derived from it have been incriminated, but on weak grounds. Finally, various parasites may be transmitted through their larvae, by infested fish eaten raw or but slightly cooked.

Symptoms.—The symptoms of fish poisoning are at first, as in the case of meat, gastrointestinal: nausea, vomiting, diarrhea, and more or less severe colic. In some cases, this is only accompanied by intense prostration, cold extremities, and a weak and rapid pulse, with more or less dryness of the throat and mouth. In the severer type, however, the gastrointestinal reaction is accompanied by vertigo, dyspnea, aphonia, and cyanosis, all with numbness and intense prostration. Relaxation of the sphincters, collapse and death may follow within a few hours.

SHELLFISH POISONING.—Mussels are said to owe their violently toxic properties to the presence of a ptomaine, mytilotoxin, but this accounts for but one of three syndromes, the two others being clearly those of *B. enteritidis* and *B. botulinus*. Oysters also have produced two forms of poisoning due to these pathogenic organisms, but these mollusks are principally harmful through the criminal cupidity of some dealers who place them in waters contaminated with sewage in order to fatten them, or owing to the carelessness of others who allow the waters of storage pits to remain unchanged several days or even weeks. It is in sewage-contaminated waters that oysters acquire the typhoid bacillus which they transmit

to their consumers. Numerous epidemics have been traced to them. *Lobsters* and *crabs* occasionally give rise to toxic phenomena, but only when eaten after their decomposition—which occurs early in these animals because of their identity as scavengers—has begun, and in canned lobster after the can has remained open. It must not be forgotten that the most active ptomaines are produced at the very start of this process. *Clams*, *shrimps*, and *cockles* occasionally prove harmful under the same conditions and in the same manner.

Symptoms.—The symptoms due to the violent ptomaine mytilotoxin of *mussels* are distinctive in the sense that they provoke marked peripheral heat and pruritus, and also a series of papular and vesicular eruptions which follow one another in rapid succession. The two other forms of poisoning this shellfish may awaken are those described under Meat Poisoning, due to *B. enteritidis*, viz., gastrointestinal symptoms, nausea, vomiting, diarrhea, etc., and *B. botulinus*, vertigo, headache, numbness, marked prostration, coma, etc. As to *oysters*, the symptoms may also be those caused by the enteritidis and botulinus toxins, but in most instances they are those of transmitted typhoid. *Lobsters*, *crabs*, *clams*, *shrimps*, etc., may cause nausea, vomiting, colic, headache, diarrhea, etc., and in others urticaria or paralytic phenomena.

MILK, CREAM AND CHEESE POISONING.—The toxic effects of *milk* have already been considered in full in the articles on NURSING AND ARTIFICIAL FEEDING, in the seventh volume, and TYPHOID FEVER in the present volume, to which the reader is referred. Besides the toxic effects described under those heads, acute intoxication from milk may occur, owing to the presence in it of essentially the same organisms that render meat toxic: *B. enteritidis*, and another bacillus of the colon group, *B. enteritidis sporogenes*, for which, particularly in warm weather, milk affords an excellent culture medium. It is always owing to the same bacteria that most cases of poisoning due to cream-puffs, ice-cream, custards and other foods of this class, occur. *Cheese* owes its occasional toxic effects partly to the same

group of bacteria of the colon group, which multiply during the storage and ripening process, and partly to a toxin termed by Vaughan *tyrotoxin*, the source of which has not as yet been determined.

Symptoms.—The gastrointestinal symptoms of the enteritidis toxin and the various types of infantile diarrhea have been reviewed in the article on this subject. Often the symptoms are clearly those of dysentery (*q. v.*). Tyrotoxin poisoning due to *cheese* also causes gastrointestinal symptoms, but often with violent chills, coldness of the surface, severe colic, marked prostration, weak and irregular heart action, and in severe cases delirium and coma. Egg-containing *custards*, *puffs*, etc., cause much the same phenomena.

MUSHROOM POISONING.—The toxic effects of mushrooms are mainly due to two alkaloids: *muscarine*—formed by the oxidation of choline in the *Agaricus muscarius*—and phalline, contained especially in the *Amanita phalloides*. *Phalline* is a toxalbumin of extreme violence, which is also found in some venomous animals, such as the rattlesnake. Both species of mushrooms, however, contain other chemical substances the nature of which has not been determined. Edible mushrooms may become toxic through putrefactive changes in them, in keeping with other foods reviewed.

Both the species of poisonous mushrooms referred to above have *white gills* and *white spores*, while all the edible gill-bearing species, except *Coprinus comatus*, have gills of some other color. In *Coprinus comatus* the spores at maturity are black. Several species of mushrooms having both white gills and white spores being edible, however, a beginner should not pick them, as he might easily mistake an *amanita* for them.

A high color, a scaly or spotted surface, and tough or watery flesh are usually associated with poisonous properties. Toxic mushrooms, moreover, grow clustered on wet or shady ground, the edible, singly, in dry pastures. Those which have a bitter or styptic taste, or which burn the fauces, or that yield a pungent milk, those of livid color, and which, on being bruised, assume various hues, ought to be avoided. It should be remembered, also, that all

plants of this class readily undergo decomposition, and should therefore be eaten as fresh as possible.

The prevailing belief that a silver piece will indicate poisonous mushrooms by becoming black when cooked with them is erroneous. If there is any suspicion that the mushrooms on hand are toxic, the following process, used by market-women in Washington, according to Mr. Coville, of the United States Department of Agriculture, can be employed before they are prepared for food: The stem is scraped, the gills are removed, and the upper part of the cap is peeled. The mushrooms are then boiled in salt and water, *which removes any toxalbumin that may be present*; then steeped in vinegar, *which removes the alkaloid*.

Symptoms.—The symptoms of mushroom poisoning differ according to which of the two alkaloids is present. Those of *muscarine poisoning* indicate a vasomotor paresis of cerebrospinal origin, following a gastrointestinal effort at elimination. After a period varying from half an hour to fifteen hours, giddiness is experienced, and nausea, with salivation, vomiting, cramps, diarrhea, dimness of vision, and dyspnea follow in quick succession. The stools sometimes contain fragments of the fungus. The patient appears drunk and excited, then drowsy. These symptoms are usually the precursors of convulsions, and are preceded by anuria. Cardiac action is weakened, and the pulse is slow and thread-like. The pupils, at first contracted, become dilated as death approaches. The reflexes are, in part or quite, abolished, and cold sweats appear. Respiration gradually becomes more difficult and stertorous, the pulse becomes imperceptible, and death occurs either in coma or in the midst of a convulsion. The symptoms may progress rapidly or slowly, some cases dying a few hours after the first manifestation, others lasting two or three days.

In favorable cases the stupor is not of long duration, the respiration and pulse are more active, and all the symptoms mentioned gradually disappear. But great care is required in this connection. The patient may appear perfectly well a few hours, and even days, and suddenly re-

lapse and die. Three days, at least, must elapse before the patient can be deemed out of danger.

In *phalline poisoning* the toxic agent tends to dissolve the blood-corpuscles, thus bringing about a condition simulating cholera. Severe cramps in the abdomen and lower limbs, particularly, come on a few hours after ingestion of the fungus. Violent diarrhea, the stools becoming choleraic (rice-water stools), vomiting, algidity, collapse, cyanosis, muscular contraction, and convulsions sometimes follow one another in more or less rapid succession; a series of symptoms differing entirely from muscarine poisoning. The symptoms increase in intensity without the mental hebetude and torpor witnessed in the latter, though, when death is approached in from two to four days, increasing somnolence, due to carbonic acid poisoning, may be witnessed.

The prognosis is far less favorable than in muscarine poisoning, 75 per cent. of the cases having proven fatal.

Treatment of Food Poisoning.—In all the foregoing forms of poisoning it is important that the patient be kept quiet and in the recumbent position to prevent heart-failure. **Lavage** of the stomach or emesis as early as possible is indicated; but, also to protect the heart, a depressant emetic such as tartar emetic should be avoided. **Apomorphine**, $\frac{1}{2}$ grain (0.005 Gm.) for an adult, or a tablespoonful of **mustard in lukewarm water**, are effective. A **saline solution enema** is helpful to evacuate the intestine, unless the stools be frequent and contain fecal matter, which indicates that physiological elimination is taking place. If the latter fails to occur, as is sometimes observed in severe cases, **croton oil**, 1 drop on the tongue, and **glycerin and water**, 1 ounce (31 Gm.) of each, injected into the rectum should be resorted to; saline cathartics should be avoided.

Once the gastrointestinal canal is relieved of its toxic contents, or before this is completed, if the prostration is severe and the cardiac action very rapid or irregular, **morphine** should be administered hypodermically, or, better, if the patient's stomach will not rebel, the **camphorated tincture of opium (paregoric)**. Either of

these opiates will very soon restore the circulatory equilibrium, the surface becoming warm, the heart stronger.

In *mushroom poisoning*, **atropine**, the physiological antidote of muscarine, should be given at once hypodermically, the dose ranging from $\frac{1}{2}$ to grain to $\frac{1}{100}$ grain (0.0005 to 0.00065 Gm.), according to age. If the case is not seen too late it causes dilatation of the pinhead pupil as soon as its physiological effects are produced. It is also useful in phallin poisoning.

To further sustain cardiac action, **digitalin** should be given at fixed intervals. **Strychnine** is also useful. **Pituitrin** suggests itself as a valuable agent in this connection, 15 minims (1 Gm.) being injected intramuscularly. The poisonous action reaches its crisis, then gradually recedes. The aim, therefore, should be to maintain life by sustaining the action of the heart throughout the dangerous period. **Hot coffee**, **chloroform liniment** rubbed in with flannel over the abdomen, and **sinapisms** to the calves, are effective adjuvants.

All cases of food-poisoning are followed by considerable depression; **strychnine**, **digitalis**, and **iron** are efficient agents in this connection.

GRAIN AND VEGETABLE POISONING.—**Ergot.**—Rye often becomes the host of a fungous parasite, *Claviceps purpurea*, when grown on virgin soil or when the soil is carelessly cultivated. Consumers of rye-bread, especially numerous in some parts of Europe, are therefore exposed to its effects, and epidemics of ergotism have thus been caused, and are apt to occur immediately after harvest. These are attributed to two active principles: cornutin and sphacelinic acid. This subject has already been reviewed under **ERGOT**. (See page 568 in the fourth volume.)

Chicken-pea.—This seed is often mixed with others used as food, and may cause, after prolonged use, nervous disorders of spinal origin, transverse myelitis especially. This is termed *lathyrism*, and is met in India and Africa.

Sprouting Potatoes.—These may at times contain a poison, solanine, an alkaloid of its botanical group, resembling in effects those of belladonna, stramonium,

hyoscyamus, and tobacco. In most instances reported, gastroenteritis came on after partaking of some cooked sprouting potatoes. The symptoms were collapse, prostration, with more or less jaundice. During sprouting much more solanine is developed. In using such potatoes care should be taken to thoroughly peel the vegetable and take out the "eyes" deeply, thus minimizing the danger. It is doubtful whether potatoes in themselves are ever toxic.

Treatment.—The treatment of ergot poisoning is reviewed in the fourth volume, referred to above. As regards lathyrism and solanine poisoning the general lines indicated are **purgatives** to insure elimination of the toxic, and stimulation with **strychnine** or **adrenaline** in **saline solution** by hypodermoclysis, to facilitate renal elimination and restore the vascular tone. **Morphine** tends also to counteract the effects of the poisons, and is indicated to relieve pain.

PELLAGRA, OR MAIDISM.—Corn is by far the most important malefactor in the series of food poisons, if it can finally be shown to be the actual cause of pellagra. The whole question, however, must still be considered *sub judice*.

The prevailing view at the present time is that this disease, also termed **maidism**, the victims of which have been estimated at 30,000 in the United States alone, is a nutritional disturbance due to the use, as food, of corn in which some bacillus has caused putrefactive changes that render it toxic. But the nature of this organism has never been determined. Many germs of the colon type, streptococci, etc., the smut of corn, molds, etc., have been incriminated by as many investigators. The antizeists or opponents of the corn theory, however, have attributed the disease to products of defective digestion, to infective agents, to water-bred insects, to the stable fly, to certain parasites, to unsanitary living conditions, to avitamiosis, etc.

The disease seems, in America at least, to show a predilection for females, the ratio being about 4 to 6. Children are rarely affected; it begins to appear about the fifteenth year, then becomes gradually more frequent until the beginning of the sixth decade, when it is most fatal, par-

ticularly among males. Negroes, especially girls, are more susceptible to it than whites. While the course of the disease is chronic, its most active period is during the summer months, considerable improvement coinciding with the onset of cool weather. It is especially common in Italy, Spain, France, Roumania and in the southern and western parts of the United States.

Pathology.—The morbid changes are clearly those of a degenerative trophoneurosis with the spinal cord as focus of morbid activity. The lateral tracts bear the brunt of the process, but the posterior tracts may also be involved, particularly in the upper dorsal and cervical regions, the changes resembling those of tabes. The muscular elements—skeletal, intestinal, and vascular—are the seat of fatty degeneration; the bones are ill-nourished and brittle. Among the more prominent changes also are those of the brain-cells, with infiltration of the meninges. Even the mucous membranes and skin are the seat of trophoneurotic changes, sometimes sufficiently marked as to cause gangrene.

Symptoms.—The earlier symptoms tend to appear during the spring with lassitude, debility, vertigo, insomnia, headache, and slight indigestion. There usually is, at this time or later, a sensation of superficial heat throughout the body, including the oral mucosa, which appears red and swollen. Gradually as the morbid process advances the orogastric symptoms become more marked. The salivary gland becoming involved, there is copious salivation; the tongue and oral mucosa become intensely congested, the former being often denuded, ulcerated or "stippled"; often a fibrinous exudate is formed resembling diphtheritic false membrane. All mucous membranes, faucial, rectal, vaginal, etc., are all intensely red. Nausea, vomiting, violent and persistent diarrhea with watery stools (occasionally hemorrhagic) are prominent symptoms, though occasionally constipation is present. Neuralgia, neuritis, muscular cramps, irritability, mental torpor, or aberration which eventually may lead to melancholia, with delusions of persecution and suicidal tendencies, or to maniacal outbursts. There

is anemia, but a blood-count and hemoglobin percentage seldom show it to be severe.

Cutaneous symptoms are prominent features of the disease. They consist of erythema, usually on exposed parts of the body, face, hands, etc., which is symmetrical. The skin is rough, and pain and exfoliation reveal an underlying suppuration, followed by dark pigmentation. Recurring attacks of the trouble lead to thickening of the pigmented areas and eventually to atrophy. Bullæ and vesicles are sometimes observed. The latter is termed the "wet" form with crevices, ulceration. Occasionally, however, the cutaneous symptoms fail to appear, causing the condition known as *pellagra sine pellagra*. Conversely, all the symptoms may appear in very rapid sequence, constituting the *fulminating type*.

As the disease progresses, all the symptoms increase in gravity, the muscular weakness becoming excessive, the diarrhea an uncontrollable, though painless, flux; the mental disorder a delirious dementia, the heart's action extremely weak and irregular. The patient dies in marasmus, when an intercurrent disease does not end his sufferings earlier. Many cases recover, however, especially during the earlier stages of the disease. The mortality averages about 25 per cent. In children in whom the disease is occasionally witnessed, recovery readily follows under appropriate measures.

Treatment.—Of the many remedies tried arsenic, in the form of **Fowler's solution** in 5-minim (0.33 Gm.) doses, gradually increased, has alone given good results, but its action should be closely watched and its use suspended a few days at intervals. **Atoxyl** is another excellent agent of this class. Babes and others have reported rapid cures by giving it hypodermically while arsenic was being given orally and by injections. The dose of atoxyl is 5 grains (0.33 Gm.); this may be increased slowly and injected intramuscularly, dissolved in cold sterile water, twice a week. **Soamin**, the arsenilate of atoxyl, has been given orally in smaller doses with success. One important feature of the use of arsenic and its congeners in pellagra, is that the treatment should be started six

weeks before the expected recrudescence of the disease during early spring, thus anticipating it. **Sodium cacodylate** has also been highly recommended. **Salvarsan** has not so far met expectations.

The diet is an important feature of the treatment. In this country, where all kinds of food are available, the **elimination of corn from the diet** is possible. In Italy, where the only food within reach of the very poor is *polenta*, made of corn-meal, laws have been provided for their protection, wholesome and dry meal being alone available. Owing to the condition of the mouth, which should be treated according to the form of stomatitis (*q. v.*, vol. vi, p. 717) present, **soft foods, peptonized milk, meat broths, well-boiled cereals, soft-boiled eggs, mashed potatoes**, etc., should be employed until the oral cavity is sufficiently restored. According to Goldberger, of the U. S. Public Health Service, a liberal amount of **fresh animal and leguminous protein foods** will nearly always prevent the annual recurrences.

Another important feature is **rest**; hence the importance of hospital treatment of those cases. **Hydrotherapy** has been extolled by many. As previously stated, **change of climate** is of great value—possibly owing in part to the radical change of diet it entails. S.

TRACHOMA. See CONJUNCTIVA, DISEASES OF.

TRANSFUSION. See VENESECTION AND TRANSFUSION.

TRAUMATIC NEUROSES. See VASCULAR SYSTEM, DISORDERS OF.

TREMATODES. See PARASITES, DISEASES DUE TO.

TREMORS.—In this section will be placed those disorders in which tremor is the predominant symptom: *viz.*, TREMOR as an independent symptom; PARALYSIS AGITANS and MULTIPLE SCLEROSIS.

TREMOR.—Though but a symptom, tremor, or rhythmical involuntary oscillations of one or more parts of the body, often leads the patient

to seek advice from the general practitioner.

While no form of tremor is absolutely distinctive of any one disease or group of them, some aid is obtained as to the nature of the morbid process by noting the relative speed of the oscillations. As was strongly urged by Crenshaw (*New York Medical Journal*, February 12, 1916) their diagnostic significance is about as follows: (1) With the exception of the tremor of Parkinson's disease, coarse tremors indicate organic disease. (2) Fine tremors indicate toxic or functional conditions. (3) Effort tremors suggest central organic lesion. All tremors are of central origin, and practically all disappear during sleep. The disease which gives us the most typical effort tremor is multiple sclerosis. This tremor is perhaps next most constant in brain tumors. Tremors affecting the face or tongue are most characteristic of alcohol and general paresis. Tremors of the head are oftenest found in senility, while trembling of the legs generally results from fear or fatigue.

To distinguish clearly the relative speed of tremors, the patient should stretch out his arms, extend his fingers, and separate them as far as possible. A fine tremor may also be detected by touching the patient's finger-tips when the hand is disposed as stated. Tremors of the tongue and face are best detected by having the patient close his eyes and protrude his tongue as far as he can. Trunk tremors are readily felt by standing behind the patient's back and placing the hands on his shoulders. Tremors may be divided into the following types:—

Senile Tremor.—This type is seldom observed before the seventh decade. It affects mainly the hands, arms, and head, and is increased by motion. It is doubtful whether a true senile tremor exists. It is usually traceable to arteriosclerosis, the excessive use of tobacco, heredity or hysteria.

Hysterical Tremor.—Tremor is commonly observed in hysteria, and may be its only objective symptom. Such a case is often traceable to heredity. Thus in a case reported by Regnault, hysterical tremor had existed in the patient's great-grandfather, grandfather, uncle, two aunts, mother, and sister. Often it follows a shock, physical or emotional, or both. It is increased by motion, also when the patient is watched or when the tremulous extremity is held, and often ceases when the patient's attention is diverted, or by an effort of his will. Internal vibrations may be complained of, which may persist during repose. The so-called *traumatic tremors* belong to this category.

Hereditary or Family Tremor.—This form differs from others, in that it affects the muscles only. All the members of a family may suffer from it, beginning during childhood in some, though later in the majority, and increasing with age. The oscillations are very rapid and occur only during voluntary motion, any muscular strain increasing its intensity. A peculiarity of this form, which greatly resembles the tremor of paralysis agitans and often is limited to the hands, is that alcoholism tends to arrest it, at least temporarily.

Toxic Tremor.—This form is often traceable to intoxication by occupational agents. That due to lead

poisoning affects chiefly the arms and legs, and is increased by muscular effort. Mercurial tremor is often confined to the face, tongue and extremities; fine at first, it may become choreiform. Ptyalism and stomatitis often appear simultaneously with the tremor. Alcohol, arsenic, copper, chloral hydrate, cocaine, morphine, ergot, and other drugs may also cause it. It may occur in miners after choke-damp poisoning, and as a manifestation of intestinal autointoxication. Prostatic hypertrophy may cause it by producing retention of stagnating urine. Malaria, syphilis, neurasthenia typhus and other adynamic diseases may also engender tremor; it is observed frequently during convalescence from severe illness under the stress of exertion.

Infantile Tremor.—Tremor is not infrequently observed during infancy or early childhood as a result of lesions, temporary or permanent, of the meninges and cortex in the course of infectious processes. As a rule it subsides without treatment; occasionally, however, imbecility follows. This unfavorable result may also occur in the unilateral tremor of children, but, as a rule, recovery may be expected, if the feeding and hygienic surroundings of the child be attended to.

Intention or Volitional Tremor.—In this form, the tremor appears only when a motion is carried out through volitional effort. Thus, as in a case of Moyer's, there would be no tremor while the hands lay in the patient's lap, but with voluntary effort they were immediately thrown into tremor. When asked to convey a glass of water to her mouth the

tremor was much more marked. This is sufficient, in some patients, to cause the water to be spilled in all directions. Writing is difficult. This is the kind of tremor observed in multiple disseminated sclerosis, treated below.

ETIOLOGY AND PATHOGENESIS.—The manner in which tremors are produced is still *sub judice*. Preston has explained it by the general fact that the normal number of contractions occurring when the muscles contract, which is 32 per second, has been found by Brouardel, Marey, Gowers, and others to be reduced to 6 or 7 per second in paralysis agitans, multiple sclerosis, mercurial tremor, etc. That they may not be due to pathological lesions is shown by the fact that they may be caused by cold, fright, anger, or great emotion. This should be borne in mind in making a diagnosis. Nervous females, especially when being examined by a physician, show often in a marked degree this acute tremor. The pathological forms may also include besides those referred to above (a) cerebral or spinal lesions, such as primary lateral sclerosis, disseminated sclerosis, ataxic lateral sclerosis, posthemiplegic affections, bulbar paralysis, general paralysis, myelitis, by compression especially, and certain forms of chronic meningitis; (b) lesions of nerves and muscles, as neuritis and muscular atrophies; (c) exophthalmic goiter, athetosis and chorea.

Adamkiewicz has urged that tremor arose from disturbances in the equilibrium of the two spinal innervating stimuli. Two currents pass along the spinal cord to the ganglion-cells of the anterior horns from which the

nerves for the muscles arise. One of these currents passes along the posterior columns, the other along the pyramidal tracts. The former arises in the cerebellum and keeps the muscles in a state of tension; the other originates in the cerebral cortex and conveys voluntary impulses to the muscles. When both currents are properly balanced, they act upon the muscles as a stimulus and as a check like whip and rein. If the excitation along the posterior columns is insufficient the muscles deprived of their check become unruly and produce ataxia. When, on the other hand, the muscles are controlled by the current along the posterior columns and the regulating action of the pyramidal tracts is absent, as, for example, in lateral sclerosis, the muscles of the lower extremities are in a state of excessive tension; so that the joints become immovable and the gait stiff, labored, and dragging. If the patient attempts to move, the hypertensioned muscles develop a state of tremor. In the beginning this tremor is slight, but in proportion as the tension of the muscles increases it becomes augmented, until finally a tremor paroxysm develops.

TREATMENT.—The multiplicity of causes of tremor render it necessary to refer the reader to the sections on the underlying diseases or poisons for curative measures. *Senile tremors* are now attributed to some pathological condition which must be carefully sought and appropriately treated. Depressants, such as the bromides, hyoscyamine hydrobromate, etc., should be avoided in the aged. **Formic acid** has been found effective.

In *hysterical tremor*, besides the measures addressed to the causative

disease itself (*q. v.*) **gelsemium**, the **bromides**, and the **faradic current** are helpful. *Toxic tremors*, due to alcohol, mercury, copper, lead, cocaine, etc., yield to the treatment of chronic poisoning by these agents given in full in their respective section. In the alcoholic form, Liégeois found that the addition of **picrotoxin** or **veratrine** to **strychnine**, and the use of **galvanic baths** gave excellent results.

Among the remedies which have afforded aid in the various forms, when these occurred in individuals capable of standing depressants without harm, may be mentioned **veronal** (Combemale) and **acetanilide**. **Atropine** in $\frac{1}{200}$ -grain (0.0003 Gm.) doses, or **arsenic**, **cold douches**, and **galvanic baths** have been recommended for sthenic subjects.

PARALYSIS AGITANS (Parkinson's Disease; Shaking Palsy).—A chronic nervous disorder characterized by tremor, muscular weakness and rigidity.

SYMPTOMS.—The tremor of paralysis agitans possesses characteristics that are not observed in other forms. As a rule, it appears insidiously after perhaps neuralgic pains, paresthesias and vertigo, though it may appear suddenly after a fright, a violent emotion, or a traumatism. It affects first the hand, beginning with a finger and extending upward, until the forearm is affected, thence to the foot, but it is so slight that the patient hardly perceives it. It may cross the body, as it were, passing from right arm to left leg, thence to the right leg, or may affect one limb only. It may disappear for days, or even weeks, then reappear with more or less increase in the

area involved. Moyer noted, in the early period of rigidity, when diagnosis was difficult, a "cog-wheel," intermittent resistance felt when examiner grasps the wrist with one hand, steadies the arm above the elbow with the other, and makes rapid flexion and extension of arm.

The peculiarity of the tremor is mainly due to the position assumed by the extremity affected. The fingers, for instance, assume the position required to hold a pen, the four straightened fingers, united at their tip, tremble simultaneously, while the thumb oscillates rapidly and synchronously in their direction. Or, as is frequently the case, the movement of the index finger and thumb is that of rolling pills. The wrist motion is one of supination and pronation. This, combined with the motions of the fingers, renders writing difficult, then impossible. The head and face may take part in the tremor, although the motion of the latter is mainly communicated to it by that of the extremities and occurs late. These movements occur while the muscles are at rest, but cease when the patient is asleep. Under the influence of the will their intensity may be reduced to a certain extent. Ultimately, however, the tremor occurs during sleep, and may interfere with the patient's rest.

The muscular rigidity is a special feature of paralysis agitans. It affects the flexor muscles, the extensors being strikingly weak, and begins by painful cramps which, though temporary at first, finally become permanent. Under the influence of this rigidity, the head, trunk, and the limbs assume special positions characterized by stiffness. The fingers

may then assume the position observed in arthritis deformans, the first phalanx bent, the second extended, and the third bent. The head may remain fixed in position, the eyes become fixed, and the features expressionless and mask-like, the so-called "Parkinson mask." There may be dribbling of the saliva, which the patient fails to swallow, or which accumulates in the mouth owing to increased activity of the salivary gland. As shown by Fränkel, there is a well-marked irregular thickening of the skin, and a peculiar adherence to the subcutaneous tissues. This is especially marked over the forehead.

When the muscles of the tongue and lips participate in the morbid process, the speech becomes difficult, slow, hesitating, monotonous, and high-pitched. Or there may be stuttering, the patient attempting to speak rapidly.

Later on the muscular rigidity causes the thighs to become rapidly raised toward the abdomen, but there is no true contracture nor the epileptoid tremor of lateral sclerosis, the rigidity being due to the fact that extension becomes impossible, though the opposite condition, fixed extension, is at times observed.

Tremor was noted in 203 of 219 cases studied in Dr. M. Allen Starr's clinic. In rare instances this symptom may be absent.

In cases of paralysis agitans which do not exhibit the usual tremor, the diagnosis can readily be made on account of the characteristic attitude and gait of the patient. The earliest signs of the disease are stated to be stiffness and clumsy movements in the upper limbs on one side. The fingers are usually specially involved, so that the movements of flexion and extension are generally early af-

fected, as may be also those of abduction and adduction. Pains in the joints, dyspeptic symptoms, and salivation are sometimes met with early in the disease. Oppenheim (*Deut. med. Woch.*, Dec. 16, 1905).

Besides the cramps already alluded to, the patient complains of a sensation of excessive heat, showing thermometrically an excess of 6° F. in some cases (Gowers). Localized sweating is sometimes observed.

The attitude and gait of the patient are characteristic. While the back is bowed and the head bent forward, the arms, flexed at the elbows, are held away from the trunk. Conversely, the knees are held so closely that they often rub in walking. This peculiar position, with the center of gravity carried forward, causes the patient to act, when he attempts to walk, as if he were falling forward; he, therefore, trots forward as if trying to save himself and cannot stop until he meets an object capable of holding him. The same disturbance of gravity causes him to fall if pushed backward.

Apart from slight paresthesia early in the history of the disease, there is as a result no disturbance of sensation; the bowels and bladder also continue to act normally in the average case.

The advanced stage of the disease is characterized by a peculiar paresis, and has been termed the "paralytic period." The tremor diminishes greatly in intensity, and the patient enters a cachectic condition, during which disorders of nutrition occur. He gradually sinks into a marasmus, with diarrhea, anasarca, incontinence of urine, and gradual reduction of mental powers. An intercurrent af-

fection, especially pneumonia, usually closes the scene.

Hypertonicity of the muscles, rather than the tremor, is the main feature of shaking palsy. Case in which, after a few months of unusual business worry, a man of 48 was assaulted by bandits and the syndrome gradually developed of Parkinson's disease, progressing till his death at 85. The nature and seat of the process responsible for shaking palsy is still a mystery, and that no authentic case of recovery is known. Rizzuto (Policlinico, Nov. 21, 1915).

DIAGNOSIS.—It is only in its early stages that paralysis agitans can be mistaken for another disease. *Multiple sclerosis* differs from it, in that it has increased reflexes and intention tremor, while the tremor is increased by muscular movement, such as bringing a glass of water to the lips. *Posthemiplegic trembling* also resembles paralysis agitans, but the history of a paralytic stroke soon points to the nature of the disease. *Hysteria* may simulate perfectly paralysis agitans mainly, however, through autosuggestiveness. By consulting the review of tremors submitted at the beginning of this section, each form can readily be identified.

ETIOLOGY, PATHOGENESIS, AND PATHOLOGY.—Paralysis agitans usually occurs in subjects above the age of 40 years, and most frequently between 50 and 60. It is oftener observed in men than in women. Emotional factors, grief, worry, shock, appear as the main exciting cause, after which come traumatism, infectious diseases, alcoholism, exposure, overwork and sexual excesses. Direct hereditary transmission can rarely be traced, though the

disease has been found to exist in relatives in 16 per cent. of the cases.

In Hart's study of M. Allen Starr's 219 cases, 31 were directly traceable to traumatism, which comes next in order in frequency, as a cause, to emotion. Ruhemann traced 7 cases out of 35 clearly to an injury, the typical phenomena appearing shortly after the latter, and growing rapidly worse, as previously emphasized by Charcot. Balz, out of 55 cases, found that in 8 the tremor developed immediately after the accident. Krafft-Ebing, in a study of 110 cases, found that in cases of traumatic origin the disease always begins at the location of the trauma, while after other causes it starts at the upper extremity, the hand, wrist, etc. Charcot believed, therefore, that the disease was due, when it followed injury, to an ascending neuritis, a view favored by Krafft-Ebing, though he was unable to find the typical lesions of neuritis. Savary Pearce attributed paralysis agitans to commotion of the brain when it occurs as a consequence of traumatism.

A disorder of the ductless glands has been suggested by various writers. The presence of several symptoms of myxedema was observed by Lundborg, Moebius, and others. Again, while thyroid extract has been found of value in cases, Horsley long ago, and also Dercum, noted that thyroidectomy caused symptoms similar to those of paralysis agitans. Castelvi found the thyroid sclerotic and atrophied in two cases of this disease. That it "might be the result of some glandular secretion" was suggested by Dana in 1899. Lundborg (1903), Berkley (1905), and others ascribed it to insufficiency of

the parathyroids, and Castelvi, to hypothyroidism.

The disease has been attributed by Moebius, Fränkel, Burzio, and others to intoxication. That toxic substances accumulated in the blood can cause tremor is suggested by Hock's case, in which an enlarged prostate was also present. During the periods of urine retention the tremor became intense, though, when the elimination of urine was not prevented, not very marked. Dana, in 1893, ascribed the tremor to "microbic toxins," and Gauthier to toxics of muscular origin. In 5 out of 7 cases, the urine was found to contain a large excess of phosphoric acid.

While these pathogenic factors, taken individually, do not account for the disease, a possible clue to its cause is suggested when all of them, collectively, are taken into account. Thus, emotion, grief, shock, traumatism, and other causes enumerated are all conditions which tend, either by *commotio cerebri* or otherwise, to debilitate the organism. That the ductless glands are themselves debilitated functionally along with all other organs is self-evident. If, with Sajous, we grant the ductless glands a leading rôle in tissue metabolism, and in the defensive functions of the body, their debilitated state renders them inadequate to carry on these functions, and the toxic wastes they should destroy accumulate in the blood, initiating and perpetuating a condition of the arteries akin to senile degeneration, but presenting elements of arteriosclerosis, as Sajous holds, sufficient to initiate and sustain the process of denutrition. Modern methods of staining sustain this view. Thus Gordinier, in

a study of 24 cases, found uniformly, thickening of the vascular walls with perivascular increase of neuroglia and sclerosis with degeneration, and atrophy of the nerve-cells and fibers.

From Sajous's viewpoint, then, the cause of paralysis agitans should not, as has been done, be attributed to a single factor. We should rather look upon the disease as the result (1) of any morbid influence capable of disturbing, through shock, emotional, traumatic, or chemical, the physical integrity of nerve-centers, cerebral and spinal, including those governing the functions of the ductless glands; (2) of a diminution of the antitoxic efficiency of the latter organs, thus permitting an accumulation of toxic wastes in the blood; (3) of degenerative changes in the walls of the cerebrospinal and muscular blood-vessels and in the nerve-cells. All these factors acting in pathological sequency, and finally conjointly, in an individual predisposed to trophic degeneration, through age or other contributory condition, best explain the development of the disease and its lethal trend.

TREATMENT.—The foregoing pathogenesis accounts for some of the beneficial results obtained, and suggests measures through which the disease may be met with some degree of success.

Organotherapy has been tried extensively in this disease, but although benefit has been claimed for various preparations, it does not appear to have effected more than improvement. Thus **parathyroid** gland was tried by Berkley, Dana, A. A. Smith, F. L. Taylor, Grinnan, Petersen, H. H. Janeway, and R. Kingman, with results varying from "improved" to

"really extraordinary improvement," a negative result being obtained in only one child. "All the patients remarked upon a curious increase in courage, comfort and mental energy while taking the remedy." Berkley states that the extract degenerates rapidly, and that it should be tested physiologically beforehand; this may account for the negative and even harmful results noted by others. **Thyroid** failed also to produce lasting results. It is probable, however, that **parathyroid extract** (gr. $\frac{1}{50}$ —0.0013 Gm.) given early in the case and gradually increased would give better results. As Sajous pointed out, and as confirmed by others since, the parathyroid is the main antitoxic factor of the thyroid mechanism. This action accounts, in the light of the pathogenesis submitted, for the beneficial effects obtained.

Encouraging results have also been obtained by treating the case as if it were one of arteriosclerosis. This subject has been considered in full in the article on that disease.

Antispasmodics merely depress the sensitiveness of the centers. They do not promote a curative process, therefore, and merely control the outward manifestations of the disease. **Hyoscine hydrobromate**, **duboisine**, the **bromides**, including **camphor bromide** and **belladonna**, are the agents most used.

Hyoscine hydrobromate, suggested by Erb, has given the best results that can be expected from these agents, i.e., temporary relief of the trembling, pain, restlessness, insomnia, and some relaxation of the rigidity. Administered hypodermically, it causes pain and dryness of the mouth, while the risk of intoxication is in-

creased. It is preferably given in small doses, beginning with $\frac{1}{200}$ -grain (0.0003 Gm.) doses, twice a day. This may be cautiously increased up to $\frac{1}{150}$ grain (0.0004 Gm.). All the nervous symptoms, trembling, restlessness, and flushing particularly, have been known to cease under the influence of $\frac{1}{60}$ grain (0.001 Gm.), but such doses cause a distressing dryness of the throat, rapidity of the pulse, and dilatation of the pupil. Only freshly prepared solutions can be depended upon. Rest aids the remedy in promoting the desired effects. The addition of **chloroform-water**, 2 drams to each dose, was recommended by Williamson, who obtained better results from this sedative than from any other.

Duboisine sulphate, introduced by Mendel, is preferred by some neurologists. It also mitigates the tremor and relaxes the rigidity. It has been employed in doses of $\frac{1}{100}$ grain (0.0006 Gm.) to $\frac{1}{60}$ grain (0.001 Gm.), but these large doses may also induce dryness of the mouth, nausea, vertigo, and visual disturbances. These signs of intolerance indicate that the use of the remedy should be discontinued.

Morphine is recommended by no less an authority than Krafft-Ebing, but its tendency to constipate and the danger of morphinism must not be overlooked. Buia recommends intravenous injections of a 5 per cent. solution of **sodium nucleinate** in normal saline solution, beginning with $\frac{1}{6}$ grain (0.01 Gm.), then giving $\frac{1}{3}$ and $\frac{1}{2}$ grain (0.02 and 0.05 Gm.) up to $1\frac{1}{2}$ grains (0.1 Gm.) every three days. Five injections should thus be given in series, to be followed by an interval of five to ten days, after

which the initial smallest dose should again be started with. When such doses no longer produce the desired febrile reaction, the amount may be increased up to $5\frac{1}{2}$ to 6 grains (0.35 to 0.4 Gm.). The solution used must always be freshly prepared.

Passive exercises have been recommended by a number of writers. My own method consists in the execution of a series of carefully arranged movements, both passive and active, by which the contractions are overcome, the joints loosened, and flexibility therefore induced. Further, education of the voluntary movements is important, especially of the extensors of the arm and flexors in the legs. **Massage to the back** is also employed. The entire surface of the body should be rubbed twice a day for from five to ten minutes.

MULTIPLE SCLEROSIS.—SYNONYMS.—Disseminated multiple sclerosis; Disseminated nodular sclerosis; Insular sclerosis; *Sclérose en plaques*.

DEFINITION.—A chronic disease of the brain and spinal cord, characterized by the presence of fibrous or sclerotic patches disseminated in these structures, the most prominent symptoms of which are intention tremor, scanning speech and nystagmus.

SYMPTOMS.—The variability of the onset, which may be sudden or gradual, and the frequent presence of lesions other than those to which multiple sclerosis is due, besides the irregular distribution of the subjective symptoms render its earlier diagnosis difficult until the characteristic symptoms enumerated in the definition appear. As we have seen, intention tremor occurs when a vol-

untary effort is made, such as raising a glass of water to the lips, picking up objects, bringing the fingers of one hand against those of the other, etc., the trembling ceasing at once with the effort. It affects also the head when it is raised from the pillow. In the second important symptom, scanning speech, the enunciation, though slow and measured, is indistinct, owing to defective co-ordination of the larynx, tongue, and lips, both the latter organs being the seat of tremor. Nystagmus, rapid oscillations of the eyeballs from side to side, is another striking phenomenon. Optic atrophy, sometimes preceded by optic neuritis, is present in 40 per cent. of the cases.

Eye symptoms may develop early and for a long time may be the only manifestations of the disease. Uthoff estimated that multiple sclerosis is responsible for 45 per cent. of all the cases of retrobulbar neuritis; Oppenheim, 50 per cent. and Fleischer 65 per cent. It occurs acute and fleeting, with recurrence in the same or the other eye, with intervals of months or years, in one case six years. The ephemeral retrobulbar neuritis with multiple sclerosis develops with the ordinary syndrome; headache, pains in and back of the eyeball, increased by movements of or by pressure on it; there may also be dizziness and flashes before the eyes, and central scotoma develops. The impairment of vision brings the patient to the physician. H. Gjessing (Norsk Mag. f. Lægevid., Feb., 1915).

Increased tendon reflexes and other spastic phenomena are commonly observed, leading ultimately to spastic rigidity. Paresis, leading up to paralysis, may occur with spastic phenomena as early signs, but the sphincters remain quite normal until

toward the close. The paretic phenomena may be ephemeral—the so-called hysterical or intermittent type—and be preceded or accompanied by disturbances of sensibility.

While these phenomena may be said to represent the *salientes* of a classical case, it must be borne in mind that the location of the lesions in the brain or various parts of the cord may alter the picture materially. Thus in the most common of these aberrant forms, the spinal, progressive paraplegia unaccompanied by sensory disturbances, may predominate. The lesions may even be localized in the sacrum, and cause disturbances of the sphincters and sexual functions, and also pains in the lower extremities. The comparatively rare cerebral type may, conversely, be initiated with vertigo, headache, vomiting, and eventually lead to melancholia, or the opposite, exaltation, imbecility, etc., though in rare instances. Apoplexy with cerebral hemiplegia has also been observed.

DIAGNOSIS.—When the Charcot triad: the intention tremor, scanning speech and nystagmus are present, the diagnosis is readily made. Multiple sclerosis differs from *paralysis agitans*, in that in the latter the tremor is not of the intentional type. From *Friedreich's disease*, which also affects several members of a family, there is flaccidity of the muscles and no spasm, nor eye symptoms. In *hysteria* the symptoms of multiple sclerosis may be faithfully reproduced, but they are ephemeral; yet post-mortem findings indicate that true multiple sclerosis may, in turn, simulate hysteria. The various forms of *tremor* should be differentiated

from the toxic forms through their history and symptoms, etc. None really present the characteristics of multiple sclerosis.

ETIOLOGY.—Multiple sclerosis is rarely met, even in European clinics where uncommon diseases are carefully sought out for purposes of study. The majority of cases occur in subjects between 20 and 40 years of age; it is sometimes witnessed in children, and occasionally in several children of the same family. But infectious diseases, syphilis, scarlet fever, smallpox, typhoid fever, and many others are its principal cause; in fact, it may follow either one of these diseases after very few weeks or months. The toxics which, we have seen, may cause tremor—lead, mercury, arsenic, copper, zinc, etc.—may also cause multiple sclerosis. Overwork, cold, traumatisms, and excesses have also been incriminated, but not on very substantial grounds.

Syphilis, in rare instances, may cause a symptomatology indistinguishable from that of typical multiple sclerosis, and this without the formation of sclerotic plaques, but by the ordinary lesions of syphilis, viz., arteritis and meningitis. Syphilis may also produce in the spinal cord sclerotic plaques resembling those of multiple sclerosis, without producing the typical symptoms of this disease. Spiller and Woods (Univ. of Pa. Med. Bull., Mar., 1909).

In a case of multiple sclerosis in a man of 18 years, whose father was syphilitic and tabetic, the most prominent symptoms were ataxia, Romberg's symptom, Argyll-Robertson pupil, transient palsies of left leg and right arm, transient oculomotor palsies, unequal pupils, tremors, and speech disturbances. Mental symptoms were those of progressive dementia and euphoria. The clinical

diagnosis was paresis, but necropsy proved it to be a case of multiple sclerosis with widely disseminated lesions. F. X. Dercum (N. Y. Med. Jour., June 8, 1912).

PATHOLOGY.—Multiple sclerosis affects both the white and gray substance, mainly the white substance, of the brain and the myelin of nerves. The patches may form anywhere, and may differ in size from that of millet seed to that of a walnut. They may occur on the surface or in the depths of the cerebro-spinal system from the brain to the filum terminale of the cord, and may number several hundreds. In the nerves, the axis-cylinders are usually respected, but their myelin may be destroyed; gliosis is marked in practically every instance. The vessels in the patches show marked alterations, their coats, the external particularly, being considerably thickened.

PROGNOSIS.—The only hopeful cases are those which show a tendency to remissions. Occasionally such ultimately recover. The possibility of apoplectiform seizures should be borne in mind when dealing with cerebral cases, and reserve be the rule as to prognosis. In steadily progressive cases showing no remissions, the outlook is always very grave. If the patient is optimistic as to his ultimate recovery, this should, however, be left undisturbed, encouragement being, in fact, decidedly helpful.

TREATMENT.—The cause of the disease should be sought, and, if possible, removed. This applies as well to the cases of toxic origin—lead, mercury, alcohol, malaria, etc. Thus, in a case of plumbic and mercurial origin the iodides and electricity will prove useful; in the malarial cases,

quinine; in the syphilitic, **salvarsan** or **biniodide of mercury**. The cases due to acute infectious diseases are sometimes benefited by the early use of the specific **antitoxin**. The **salicylates** may prove helpful where rheumatism—itsself perhaps due to streptococcic infection—may be traced. While the patient's strength should be conserved, confinement to bed is harmful. So are warm baths, marriage, and pregnancy. **Light massage** or **effleurage**, **regulated gentle exercises** in the **open air**, in a **warm climate** are helpful. Of the remedies which have shown some value in practically all cases of undetermined origin have been **arsenic** in small doses, and **potassium iodide** also in small doses. **Scopolamine hydrobromide** is useful to check the tremor.

The writer gives every second or third day a hypodermic injection of 15 minims (0.9 c.c.) of the following solution:—

R **Scopolamine hydrobromide** .. gr. $\frac{3}{4}$ (0.013 Gm.).
Distilled water.. 3v (20 c.c.).
Cherry laurel water 3v (20 c.c.).

M.

The treatment should be suspended if symptoms of intolerance are shown, such as mydriasis, dryness of the throat, sleeplessness, etc. Boteano (Jour. de méd. de Paris, Apr. 4, 1908).

Thiosinamine has been recommended by Fränkel, but the numerous cases of this rare disease to which he refers suggest the possibility of erroneous diagnosis in a large number of instances, the drug having proven inefficient in other hands.

Thiosinamine often does a great deal of good. During the last four years 75 cases of multiple sclerosis were treated with this drug by the

author, and of these 33 showed no improvement and 15 a decided improvement. One course of treatment usually consisted of one injection of 2.3 c.c. (37 minims) every third to fourth day into the nates for six weeks. **Baths, massage, gymnastics and electricity** assist the action of the drug. M. Fränkel (Neurol. Centrabl., nu. 1, 1913).

J. MADISON TAYLOR,
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TRICHOCEPHALUS DISPAR.

See PARASITES, DISEASES DUE TO.

TRICHOPHYTOSIS.—Trichophytosis, or ringworm, is a fungous disease attacking the general surface of the body, the scalp, the beard, and the nails. It may be caused by either of two parasitic fungi—the *Microsporon audouini*, or small-spored fungus, and the *trichophyton*, or large-spored fungus, of which there are several varieties.

The varieties of ringworm are: (1) *Tinea circinata* (ringworm of the body, herpes circinatus, tinea trichophytina corporis); (2) *Tinea tonsurans* (ringworm of the scalp, herpes tonsurans, tinea trichophytina capitis); (3) *Tinea sycosis* (barber's itch, parasitic sycosis, ringworm of the beard, tinea trichophytina barbæ); (4) *Tinea cruris* (ringworm of the genitocrural region, tinea trichophytina cruris, eczema marginatum); (5) *Tinea unguium* (onychomycosis, ringworm of the nails). Varieties 2, 3, and 5 have already been considered. (See TINEA in the fifth volume, page 159.)

SYMPTOMS.—*Tinea circinata* is characterized by vesiculosquamous patches, in the shape of rings, upon the cutaneous surface. Beginning as irregular, pea-sized, hyperemic, scaly patches, they assume, in a few days, a circular shape with very fine papules or vesicles around the border. As the patches spread, the centers heal and the patches become ring-shaped, dull pink or red in color, with borders slightly elevated and the seat of a brawny desquamation. Gyrate lesions are formed by the confluence of adjacent patches. Exceptionally patches are observed with several concentric rings, or the centers may not become cleared, in

which case the lesions are circular, but not annular. More rarely, the lesion is an elevated plaque with deep involvement of the skin, small pustules occupying the sites of the hair-follicles. The lesion of ringworm is often a solitary one, usually few in number, more rarely in large numbers on the face, neck, arms, backs of the hands, and body. Itching is usually slight.

In *tinea cruris*, the lesion very closely resembles that of eczema intertrigo, the patches being dull brownish-red in color, the border often with well-defined margins, at times slightly elevated. The eruption may spread very rapidly, involving the thighs, groins, genitals, mons veneris, and nates. Eczema is a frequent complication, with severe itching, especially at night.

In *tinea imbricata*, a form of tropical body ringworm, large areas of the body become the seat of brownish, concentric rings, and large-sized scales, giving the body the appearance of being clay-covered. The face and scalp are usually unaffected.

ETIOLOGY.—*Tinea circinata* is more common in children. It is transmitted by contact and through toilet articles (towels, etc.). Cats and dogs are a common source of the disease.

PATHOLOGY.—The fungus is found in the epidermis, especially in the corneous layer. The mycelium, consisting of long, slender, sharply contoured, bifurcated, joined threads, is abundant. The spores, rounded, highly refractile bodies, varying from $\frac{1}{1000}$ to $\frac{1}{600}$ inch in diameter, are scanty. For examination, the scales are scraped off with a knife, placed on a microscopic slide, a drop of caustic potash (10 to 40 per cent.) added, and the cover-glass applied with sufficient pressure to flatten out the scales. The fungus can be seen with a $\frac{1}{6}$ -inch objective, but more in detail by using a $\frac{1}{2}$ immersion lens.

PROGNOSIS.—Although this disease usually yields promptly to treatment, *tinea cruris* is more rebellious.

TREATMENT.—Parasiticide ointments and lotions, of mercury, sulphur, beta-naphthol, resorcin, tar, picric acid, sodium carbonate, iodine, and chrysarobin are all

efficient. **Sodium thiosulphate** solution (1 to 8 of water) and **mercury bichloride** ($\frac{1}{2}$ grain—0.03 Gm.—to the ounce—30 c.c.—water) are effectual applications.

Care must be taken in tinea cruris to prevent an acute dermatitis; soothing parasitocides are best here; the stronger remedies should be avoided.

Cutaneous epidermic ringworm is cured by **tincture of iodine** diluted with five times its volume of alcohol. When ringworm is unaccompanied by inflammation, as in the common ringworm of children, the **X-ray** well managed is the method of election (Sabouraud). W.

TRIGGER FINGER. See TENDONS, BURSÆ AND FASCIÆ, DISEASES OF.

TRIONAL.—Trional, or diethylsulphonemethylethylmethane ($C_8H_{18}S_2O_4$), is the trade name of *Sulphonethylmethanum*, U. S. P., an oxidation product of mercaptol. It occurs as colorless, lustrous, odorless, crystalline scales, having a bitter, camphoraceous taste in watery solution. It is soluble in 195 parts of water at 77° F. (25° C.), more readily in boiling water, and readily soluble in alcohol and ether. It is given in doses of from 15 to 30 grains (1 to 2 Gm.), in powder, capsule, or cachet, in seltzer water, or with large quantities of hot liquids, milk, soup, or beer, because of its sparing solubility; it should not be massed except on addition of other agents to aid in its disintegration.

PHYSIOLOGICAL ACTION.—H. Koppers found that trional acts upon the cortex of the brain, that it does not affect the respiration rate, that blood-pressure is slightly reduced, and that a certain amount of caution should be used in cardiac cases. Later experiments by Shick, and confirmed by Ott, show that trional does not affect the irritability of motor nerves, leaves the sensory nerves intact; but depresses the reflex excitability and acts as a narcotic. Trional at first hastens the pulse rate, but afterward depresses it, the arterial tension being at first raised and then afterward lowered. The respiration rate is slightly increased. Kornfeld claims that trional acts by depressing the central nervous centers and

along with others the vasomotor center, and hence the fall in blood-pressure. The action of trional is more marked if the patient is quiet and not disturbed by pain or excitement. Action normally takes place in 20 to 30 minutes after the drug is ingested.

POISONING BY TRIONAL.—There appears to be a strong resemblance between the symptoms due to the cumulative effect of trional taken for a considerable length of time and those due to acute poisoning.

The symptoms of acute poisoning are those of acute gastrointestinal poisoning with marked loss of equilibrium, vertigo, ataxia, vomiting, and watery diarrhea, which may change abruptly into constipation. The bodily temperature becomes subnormal, the pulse becomes small and rapid. The urine becomes strongly acid and there may be hematuria with hyaline and granular casts and albumin. Somnolence, hallucinations, marked cutaneous hyperesthesia, stertorous breathing and cyanosis have followed in some cases; in others dizziness, headache, and tinnitus aurium.

Chronic trional poisoning is characterized by anorexia, vomiting, constipation, and epigastric pain. Collapse and death may supervene. Hematoporphyrin is usually found in the urine and casts are not infrequent. Cardiac weakness appears and dilatation murmurs may develop at the aortic and mitral valves. Multiple neuritis is not uncommon.

Treatment of Poisoning by Trional.—If seen promptly, siphon out the stomach with plenty of warm water by means of a stomach-tube. In absence of tube give emetic of mustard (4 drams in 1 to 4 fluid-ounces—15 Gm. in 30 to 120 c.c.—water), zinc sulphate (20 grains in 1 fluidounce—1.3 Gm. in 30 c.c. water), or 2 to 4 minims (0.12-0.25 c.c.) of a 2 per cent. solution of apomorphine hydrochloride hypodermatically. To eliminate the drug from the system give spirit nitrous ether, 1 to 2 fluidrams (4 to 8 c.c.) and magnesium sulphate, 1 ounce (30 Gm.) in a tumblerful of water. Give freely of water made alkaline with sodium bicarbonate. To counteract the depressing symptoms, give abundance of strong coffee or citrated

caffeine, 2 to 3 grains (0.12 to 0.2 Gm.); for cardiac weakness give camphor, and for colic administer morphine.

THERAPEUTIC USES.—Trional is chiefly used as an hypnotic. Sleep is usually induced promptly, within 10 or 15 minutes, the sleep being calm and natural and the awakening normal and free from after-effects, except that there is a tendency to sleep during the next day.

If the drug has no effect after 2 or 3 successive nights, it should be replaced by some other hypnotic. Interruption in its use from time to time is advised to avoid cumulative effects. The constipation caused by its use should be relieved by appropriate remedies, and the hyperacidity of the urine diminished by the use of alkaline drinks.

In **epilepsy**, S. Weir Mitchell found that trional was beneficial; either the number of attacks was diminished, their severity lessened, or the general physical condition of the patient improved. In simple **agrypnia**, **melancholic depression**, conditions of moderate **oppression**, as well as in **mania** not attended by violent hallucinations, a refreshing sleep of from 6 to 8 hours was often obtained from the use of trional. In the more active conditions of excitement of **chronic mania**, and in **paralysis accompanied by moderate motor restlessness**, larger doses (30 grains—2 Gm.) gave reliable results, the effect being absent or very slight on the first, but satisfactory during the following days. In paralytics suffering from extreme motor and psychical maniacal excitement satisfactory effects were seldom obtained from similar doses, while in many cases 45 grains (3 Gm.) proved inactive. W.

TROPACOCAINE.—This alkaloid [$C_{14}H_{14}NO(C_7H_5CO)$], called also benzoylpseudotropine, is obtained from the leaves of a Java coca plant. It differs markedly from cocaine in its constitution and also in its therapeutic effects in having slight mydriatic properties, besides being about one-third as toxic as cocaine, but in no wise inferior in local anesthetic power. The hydrochloride is usually employed in solutions varying from 3 to 5 per cent. and in amount not exceeding 1 grain (0.06 Gm.).

PHYSIOLOGICAL ACTION.—The action of tropacocaine hydrochloride as a local anesthetic in ophthalmology has been studied by Annin. The tests were made with 3 and 5 per cent. solutions in boiled water or normal physiological salt solution. The dropping of the solution into the eye causes some burning and lachrymation. Anesthesia of the cornea and conjunctiva is complete in one minute, but does not last very long; 3 drops of a 3 per cent. solution causes complete anesthesia lasting from 2 to 4 minutes, and is followed by an incomplete anesthesia for 2 to 3 minutes; from 3 drops of the 5 per cent. solution complete anesthesia lasts 3 or 4 minutes, followed by an incomplete anesthesia for 2 to 5 minutes. Tropacocaine has a slight mydriatic effect, but practically no effect upon accommodation or intraocular pressure. The diffusion into the anterior chamber is considerably increased, especially when the solution is made with plain water. The corneal epithelia are softened, but the deeper layers of the cornea are unaffected. Tropacocaine does not become changed on boiling; its solution can therefore be easily sterilized. Solutions in distilled water may be kept for months without losing their anesthetic power or developing fungous formation.

When full doses are administered by lumbar injection, a feeling of oppression, occasional pallor, cyanosis of the lips, and a tendency to syncope are noticed. The blood-pressure is lowered and respiratory depression occurs. After the anesthetic effects have passed off there are sometimes headache and backache; in a few instances a trace of albumin appears in the urine, due apparently to some toxic action of the drug on protoplasm, but no permanent ill effects on the kidneys have been reported.

UNTOWARD SYMPTOMS are met with diffusible stimulants, pituitrin, saline infusion and artificial respiration.

THERAPEUTIC USES.—Tropacocaine is used as a local anesthetic for short operations on the eye and skin, and extracting teeth and roots. It may be used for applying painless cauterization, in the treatment of peripheral neuralgias, contusions, distortions, sprains, painful

bruises, etc., in arthritic pain, and as a means of diagnosis in differentiating between peripheral, central, or reflex neuralgic processes, and between simulated and actual pain.

It is used by lumbar puncture, for operations on the legs and perineum, $\frac{1}{4}$ grain (0.05 Gm.) being sufficient, but for abdominal operations 1 grain (0.06 Gm.) is required; it should not be used on children less than 14 years old, but old age is not a contraindication. W.

TRYPANOSOMIASIS, or SLEEPING SICKNESS.

—This disease is rarely observed outside of Africa, where it is due to the presence, mainly in the blood and cerebrospinal fluid and swollen lymph-nodes, of a parasite, the trypanosoma, a flagellated hematozoön commonly found in animals. The parasite is about three times the diameter of a red corpuscle, fusiform and prolonged into a single flagellum at one end. It is transmitted to man through the bite of the tsetse fly (*Glossina palpalis*), which is not known to exist on the American continent.

SYMPTOMS.—The period of incubation, though not clearly established, is very long. While the onset is gradual in negroes, in the white race it may be sudden and manifest itself by fever, but without chills or marked sweating, which lasts from two to four days; it is followed by a remission during which hypothermia may occur, and is uninfluenced by quinine. Enlargement of the posterior cervical lymph-nodes, often followed by polyadenitis, is usually discernible soon. At first the nodes are no larger than a small pea and soft, but on puncture are found to contain trypanosomes. They afford, therefore, opportunity for early diagnosis. Deep-seated pains and marked sensitiveness of the tissues on pressure also appear early.

Cutaneous lesions are more apt to occur in the white than in the black race. They usually consist of papulovesicular patches of erythema, especially numerous on the thorax; areas of edema beginning, as a rule, in the eyelids, may extend to the face, then appear at the ankles and sometimes involve the whole body.

The foregoing symptoms may constitute

the whole syndrome for a long time in a given case. Then appear the nervous phenomena which coincide with the appearance of trypanosomes in the subarachnoid space and other areas of the cerebrospinal system. While the patient becomes listless and dull and readily lapses into periods of drowsiness, vagaries of disposition, emotional outbursts, weeping, anger, etc., intersperse at first the growing mental torpor. Tremors and even epileptic seizures and also symptoms of insanity with homicidal tendencies and one of various spinal disorders may appear, especially in the white race.

The mental torpor during the intervals between these acute manifestations is now accompanied by the symptom which distinguishes the disease. As the hebetude increases, drowsiness becomes more marked, until it lapses into a practically continuous sleep. At first the patient may be roused, especially at mealtime, but this becomes increasingly difficult. A stuporous state then leads to coma and the patient dies unless, as is often the case, an intercurrent disease carries him off before this stage is reached.

DIAGNOSIS.—During the long period of incubation and before the fever stage begins, the only signs are the enlargement of the cervical glands and the presence of trypanosomata in fluid drawn from these nodes. After the fever stage has begun the afternoon febrile process and also the change of disposition, excitability, etc., will afford additional evidence. The inefficiency of quinine in the treatment is also suggestive. For the detection of the parasite the Romanowski technique (see vol. v, p. 379) should be employed. It is not always readily found and a daily examination for a considerable period is sometimes necessary early in the history of the case.

PROPHYLAXIS.—Wherever it has been possible to rid the land of bush, grass, etc., on the shores of rivers, lakes, etc., where the blood-sucking *Glossina palpalis* thrives, great good was done. Removal of an infected tribe to an uninfected region also proved preventive; but on return to the infected region, the insects were not found to have lost their power to convey the trypanosome owing

to the presence in the region of infected animals, game, etc. The partially clad natives being more frequently attacked than the Europeans, covering of the exposed tissues with mosquito netting and screening of dwellings are also indicated.

TREATMENT.—Arsenical preparations have on the whole given the best results. **Atoxyl**, which is more toxic when given by the mouth than when administered intramuscularly, $7\frac{1}{2}$ grains (0.5 Gm.), may be given twice weekly in 10 per cent. solution. Mercier and Gamble have cured thus 66 per cent. of their cases. Atoxyl acts directly upon the trypanosomes and they gradually decrease in number. It is most efficient before the nervous phenomena appear, and should be persisted in, but discontinued for a time if toxic symptoms—headache, faintness, dryness of the throat, strangury and disturbances of vision—appear. **Arsenophenylglycin**, a yellow light powder introduced by Ehrlich, is also very efficient, but more poisonous than atoxyl. Among alternates or substitutes which have been used with more or less satisfactory results where atoxyl could not be obtained have been **sodium cacodylate**, **quinine cacodylate**, **Fowler's** or **Donovan's solutions**, **arsenous acid**, and **iron arsenate**. The young were found by Laveran to yield more readily to treatment than adults. In some cases a combination of two preparations succeeds where a single one fails. The addition of **strychnine** to the arsenical used is also helpful. A change of the kind of preparation is sometimes necessary, Ehrlich having shown that trypanosomes gradually acquire an artificial immunity to certain drugs. **Salvarsan** and **neosalvarsan** have not met expectations.

Report based on 370 cases. In the first or fever stage best results are obtained by a combined oral, intramuscular, and intravenous treatment. Orally the following is used: **Tartar emetic**, $\frac{1}{2}$ grain (0.03 Gm.); **caffeine**, 2 grains (0.12 Gm.); **tartaric acid**, 5 grains (0.3 Gm.); **tinctures of opium** and of **nux vomica**, of each 5 minims (0.3 c.c.); **chloroform water**, enough to make 1 ounce (30 c.c.). One ounce *t. i. d.*, in water. Intramuscularly, **soamin**, 0.25 to 0.77 Gm. (4 to 12

grains), is given every five days. Intravenously, a 2 per cent. solution of **tartar emetic** is used on alternate days in doses of 4 to 12 c.c. (1 to 3 drams), increased by 1 c.c. (16 minims) at each injection until toxic symptoms arise. The dose is then reduced by 1 c.c. and maintained. A week's rest is given after five weeks' treatment. Recovery followed in 3.9 per cent. of cases and improvement in 27.9 per cent. Masters (Jour. of Trop. Med. and Hyg., Feb. 1, 1918).

Various antimonial compounds have been used with some success. Ranken (1913) found **precipitated metallic antimony** the most effective agent, beginning with a 1-grain (0.065 Gm.) dose, watching closely its effects, and if no untoward result occurs, $1\frac{1}{2}$ grains (0.1 Gm.) repeated at intervals of four days. Each dose is stirred in a glass mortar with $\frac{1}{2}$ ounce (15 Gm.) of saline solution, a funnel and tube, with a large needle, being used. **Saline solution** is run in before and after the antimony suspension. The **sodiotartrate of antimony** may be given in from 1 to 2 grains (0.06 to 0.13 Gm.) with a glassful of water, but orally only. Various other salts are being tried, including the supposedly non-toxic **trioxide of antimony**, in a 30 per cent. oil emulsion given intramuscularly. Antimonial preparations have been found to act harmoniously with arsenical preparations, and as temporary substitutes. Among other agents tried may be mentioned **trypan-red**, **parafuchsin** and other dyes; **mercuric bichloride**, **methylene blue**, **thyroid gland**, etc., but none, so far, have approached in value either the arsenical or the antimonial preparations. S.

TUBERCULOSIS, ACUTE.—

Acute tuberculosis is the result of a more or less sudden development of a tubercular process either in the body at large or in one or more organs. It may be primary or secondary, and usually follows a rapid and fatal course. It is mainly observed clinically in the form of *acute military tuberculosis* and *acute pneumonic phthisis*.

ACUTE MILIARY TUBERCULOSIS.

Acute miliary tuberculosis is the result of a sudden formation of miliary tubercles in one or more organs. In the vast majority of instances the primary focus of infection is either a pulmonary tuberculous nodule or a group of tuberculous lymphatic glands, the tracheobronchial nodes in particular. Any tuberculous structure may, however, act as focus of infection and thus initiate a fulminating type of tuberculosis which may prove fatal within a few weeks. The pre-eminent rôle of tuberculous bronchial glands in the process, and the various signs through which their presence may be recognized, have been reviewed in the article on the THYMUS AND LYMPHATIC GLANDS, on page 538. The lymphatic vessels and veins, into which a tuberculous abscess may rupture, represent the most usual intermediaries for the dissemination of the infection. Acute tuberculosis occurs in most instances in adolescents and children.

Three forms or clinical varieties of miliary tuberculosis are recognized: the *general or typhoid form*, in which the morbid process is widespread; the *pulmonary form*, in which the lungs are invaded, and the *meningeal form*, in which the pia mater and often its corresponding membrane in the spinal cord are invaded by miliary tubercles.

SYMPTOMS AND DIAGNOSIS.

—**General or Typhoid Form.**—The symptoms resemble closely those of typhoid fever. The incubation period, which may last a few days or weeks, is attended by prostration, general malaise, headache, and sometimes chills. Then follows, in most cases,

more or less fever, which tends to increase rapidly, the temperature reaching 104° F. (40° C.) or more. Occasionally, however, afebrile cases are met. With the high fever there appear mental torpor, hebetude, soon followed by low delirium, with the typical dry and brownish tongue of the typhoid state, the face being either pale or dusky, the cheeks showing a circumscribed bluish or reddish area. The evening rise of temperature may also occur, but not regularly, the diurnal rise sometimes appearing in the morning. The pulse is extremely rapid, and out of proportion with the fever.

The respirations are hurried, and more or less cyanosis is usually observed. There is some cough, but the expectoration is slight and mucoid unless a tuberculous focus be present in the lungs. Profuse sweating and sudamina are common and herpes likewise, but rose-colored spots are rarely, if ever, witnessed. The spleen is usually enlarged; there is no diarrhea, but intestinal hemorrhage may occur. The choroid is often the seat of tubercles. Some degree of pericarditis, pleurisy, peritonitis, or meningitis may complicate the case. The prostration, stupor, and emaciation increase rapidly and the patient soon succumbs. Often this occurs as a result of one of the complications just mentioned.

The diagnosis is at first difficult, the disseminated form being often mistaken for typhoid fever. But there are many distinguishing points. The presence of a tuberculous focus has already given rise, as a rule, to suggestive symptoms which the history of the case will reveal. The irregularity of the fever curve, the occa-

sional morning rise and the unduly rapid pulse considered together are also suggestive. While epistaxis is rarely observed, petechiæ are practically never seen. The respirations are labored and rapid, while cyanosis is usual. Finally, while the Widal reaction is negative, the von Pirquet reaction for tuberculosis is positive.

Pulmonary Form.—This type differs from the former in that the brunt of the acute process manifests itself in the lungs. Any structure in these organs or all its component tissues may suddenly become invaded: the alveolar walls, the peribronchial and perivascular tissues, the parenchyma, etc. Hence the resemblance of the disease to bronchopneumonia. Its starting point may either be, as in the typhoid type, a nidus of tubercles anywhere in the body, especially in the bronchial glands, but often it occurs as a sudden complication of chronic pulmonary tuberculosis. Again, it may follow an acute infectious disease, pertussis, measles, typhoid fever, etc., or any other disorder capable of severely debilitating the body and its defensive efficiency, thus rendering it readily vulnerable to infection. In the latter case, there is a general failure of what health may have been recovered after the acute disease. When a tuberculous focus is the source of infection, no period of incubation is apparent, a sudden rise of temperature, running more or less continuously for some time and reaching often to 105° F. (41.8° C.), inaugurating the acute process. Here again we meet, now and then, the exacerbation of temperature in the morning, which distinguishes the disease from typhoid fever. Rarely no febrile phenomena appear.

Respiratory phenomena occur early. Dyspnea soon becomes intense, especially in children in whom a respiratory rate of 80 and over per minute is not infrequent, with more or less dyspnea and cyanosis. These phenomena may be preceded by cough which persists and is sometimes severe. Cheyne-Stokes breathing is sometimes observed. The expectoration presents no special characteristic, although it may contain tubercle bacilli, and occasionally resemble the rusty sputum of pneumonia. Late in the history of the case, however, it is mucopurulent. Bronchovesicular breathing and subcrepitant râles and dullness over areas of consolidation are the main physical signs elicited.

In children the pulmonary form of miliary tuberculosis may run a very rapid course, but in adults its progress is less rapid, as a rule, than the generalized or disseminated form.

Meningeal Form.—In this variety the onset of miliary tubercles occurs in the basal pia mater, the morbid process extending in some instances to the corresponding spinal membrane. As shown by Holt, 70 per cent. of cases of acute meningitis in young children are due to tuberculosis, while in these and in infants it is usually a manifestation of a general infection. This form is usually divided into three stages: 1. *Stage of cerebral excitement*, which comes on more or less suddenly with nausea and vomiting, severe headache, great irritability, or convulsions, soon leading at times to coma. The *hydrocephalic cry*, which consists of screams, short or prolonged, due to intense pain; alternating pallor and flushing; the *tache cérébrale* of Trousseau, a

red streak formed by passing the nail lightly over the surface; exaltation of the senses causing photophobia, tinnitus, hypersensitiveness to sound, muscular spasms with rigidity, opisthotonus, and moderate fever are prominent signs of this stage. 2. *Transitional stage*, in which the acute symptoms subside; mental torpor, delirium, strabismus, retraction of the head, obstinate constipation, tremors, twitchings, convulsions, followed by paralysis of various muscles of the iris and lids, face and limbs, areas of flushing; the abdomen being often retracted or scaphoid. 3. *Stage of paralysis*, with stupor interspersed with convulsions. This includes spreading of the paralytic areas, hemiplegia, aphasia, amaurosis, anesthesia, etc., indicating the gradual failure of all motor centers. A typhoid state of short duration may then supervene, followed by collapse, Cheyne-Stokes breathing, hypothermia and death with or without convulsions.

The disease lasts three or four weeks, as a rule, sometimes longer. Recovery is occasionally observed, however. A malignant form inaugurated by violent convulsions has been known to cause death in a few days, while, conversely, some cases have dragged on sufficiently long to be regarded as chronic.

DIAGNOSIS.—Although acute miliary tuberculosis may be confounded at first with many disorders, owing to the several forms in which it may occur, the presence of an antecedent tuberculous disease, its usual prevalence in children and adolescents, the presence of tubercles in the choroid, and finally the von Pirquet test soon indicate the true character of the disease.

PATHOLOGY.—The pathology of tuberculosis in its various forms being reviewed at length in the succeeding general article, the reader is referred thereto for this division of the subject.

TREATMENT.—The statement that the treatment of miliary tuberculosis is futile or purely palliative, often met in textbooks, is unfortunate. The occurrence once in a while of a recovery indicates that the defensive resources of the body can occasionally oppose the morbid process successfully. Our efforts should aim, therefore, to enhance the efficiency of those resources. This may be done by administering small doses of mercury as early as possible, preferably the **biniodide of mercury**, $\frac{1}{32}$ grain (0.002 Gm.) every three hours. Wright recommends the **succinimide of mercury**; he injects intramuscularly from 5 to 13 drops of an aqueous solution, 10 minims (0.65 c.c.) of which contains gr. $\frac{1}{2}$ (0.013 Gm.) of the succinimide. Six injections in the course of ten days suffice. **Guaiacol** or **creosote carbonate**, 10 grains (0.65 Gm.), every three hours is also useful. **Tuberculin** in small doses by the mouth or by injection may provoke a salutary reaction if used early. **Euophen inunctions**, using an ointment 15 grains (1 Gm.) of euophen to the ounce (31 Gm.) of petrolatum rubbed thoroughly into the back and posterior part of the scalp night and morning, have also proved curative, according to Mowat, when given with small doses of **potassium iodide** and the **bromides** to control the convulsions. **Thyroid gland** in 1-grain (0.065 Gm.) doses, every three hours, with **digitalin**, $\frac{1}{10}$ grain (0.006 Gm.) for an adult or correspondingly less for a child, is also useful to enhance

the defensive efficiency of the blood and phagocytes.

In the meningeal form **spinal puncture** every second or third day relieves suffering and reduces the excessive respiratory rate. **Morphine** hypodermically is also indicated to relieve the severe suffering. **Hexamethylenamine** has been used as a bactericidal agent, owing to its penetration into the central nervous system.

ACUTE PNEUMONIC PHTHISIS.

This disease, also known as **acute phthisis**, **florid phthisis**, and popularly as **galloping consumption**, is characterized by a rapid invasion of the lungs by tubercle bacilli derived either from a tuberculous area in the lung itself or in some other organ, or from the exterior through infection, and tending to progress rapidly toward a fatal issue.

SYMPTOMS.—In the adult, acute pneumonic phthisis is initiated by symptoms resembling so closely those of *acute lobar pneumonia*, that the possibility of the actual condition present only suggests itself when the expected crisis is missed. Following a cold, a period of lassitude or slight malaise there occurs a chill with fever and cough. While at first the sputa are mucoid, they soon become rusty and a bronchial hemorrhage may follow. More or less pain on the affected lung, sometimes on both sides, and dyspnea are complained of. All these symptoms steadily grow worse; the fever reaching often 105° F. (41.8° C.), and being accompanied by severe night-sweats, rapid emaciation and extreme prostration. The sputa are now purulent, and may be found to contain tubercle bacilli and elastic

tissue. Consolidation of one or more lobes and areas of softening may now be discerned by the physical signs, submucous and subcrepitant râles. The downward course proceeds rapidly and leads to death in from three to six weeks, though in some cases the progress of the disease is slower. This occurs particularly when periods of remission are noted.

A milder or subacute type is also witnessed in which, though the symptoms are virtually similar to the foregoing, the brunt of the infection occurs in the *bronchi* and *pleura*, and leads to a typhoid state which may end in death. The course of this disorder is slower and attended with remission. Such a case may prove fatal in from two weeks to two months, or, as is occasionally the case, pass into chronic pulmonary tuberculosis.

In children the disease occurs in the form of an *acute bronchopneumonia*, usually as a sequel to measles, pertussis, scarlet fever, teething, or any disease of childhood which has greatly exhausted the auto-protective resources of the little patient. Marked fever, stubborn cough and distressing dyspnea and other symptoms of bronchopneumonia (see second volume, page 675) appear, but intensified and tending toward a rapid exhaustion of the sufferer. It differs also from ordinary bronchopneumonia, in that tubercle bacilli and elastic tissue are found in the sputum. Death occurs, as in the preceding form, in from two weeks to two months.

TREATMENT.—The treatment is the same as that for acute miliary tuberculosis, described above, in addition to the measures indicated in the various diseases: *lobar pneumonia*,

bronchitis, pleurisy or bronchopneumonia simulated, but with the tubercle bacillus as pathogenic factor.

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TUBERCULOSIS, CHRONIC PULMONARY.—Tuberculosis is due to the presence in the body of the tubercle bacillus and of the toxins the latter elaborates, and also to the reactions provoked by these irritants. Chronic pulmonary tuberculosis occurs when the brunt of the tuberculous process manifests itself in one or both lungs, and develops more or less slowly therein.

SYMPTOMATOLOGY.—Although tuberculous infection occurs in from 50 to 70 per cent. of all persons, it does not develop in all, a large proportion never having symptoms or disability due to the infection. Among those in whom it produces recognizable symptoms the type of the disease developed varies greatly owing to the variability of the defensive reactions, which may be either delayed, deficient, aberrant, or excessive in different individuals—or, indeed, in the same individual at different times. Thus it is that, in the latent types, pulmonary tuberculosis may heal without ever being recognized, or that the symptoms produced may be due to an excessive reaction of one of the protective mechanisms and not be referable to the lung at all, and that periods of progression may alternate with periods of apparent arrest. The clinical varieties of this disease are therefore more numerous than is generally believed and the symptomatology more multiform.

It is customary to include in these clinical groups, acute pneumonic phthisis,

reviewed under the foregoing heading, chronic ulcerative phthisis and fibroid phthisis considered in the present article. In its course, however, tuberculosis may pass from one form to the other, exacerbations and quiescence following each other and acute processes breaking out in those with latent tuberculosis. The frequency with which tuberculosis is unrecognized or even unsuspected, at least for long periods, by even competent physicians is probably due to the textbook practice of giving a picture of the disease or describing its clinical course, when such picture or description applies only to a small proportion of cases which are frank and open. Consequently, in this article, the different symptoms will be described separately.

Loss of Strength.—A tendency to tire easily both mentally and physically is the most constant and probably the earliest symptom of tuberculosis, being a prominent manifestation of the latent form.

So-called neurasthenia or chronic fatigue is extremely common, frequently so predominating in latent and healed tuberculosis that the tuberculous nature of the trouble is missed. It is seen especially in the resisting members of tuberculous families.

Marked weakness occurs in the more advanced and in the toxic cases.

Indigestion.—Irritability of the stomach with eructations, occasional pyrosis, sour taste, often nausea, vomiting, heartburn, and epigastric heaviness, fullness and distress—usually occurring an hour or two after a meal and relieved by eating, is a common symptom, frequently being the predominant one in latent tuberculosis. In more advanced cases the stomach often undergoes dilatation and even anatomical changes, such as chronic atrophic gastritis, with hypochlorhydria now predominating. Vomiting

occurs as a troublesome symptom, coming on after or during a severe coughing spell.

Anorexia.—Loss of appetite is an early and common symptom.

Anemia.—Early and latent cases often present a picture of anemia or chloro-anemia with its customary symptoms.

Autonomic Disturbances.—Vasomotor changes and the phenomena of autonomic ataxia occur in the majority of all types of tuberculosis, including the latent and healed forms. In the order of their frequency these are sweatings, exclusive of night-sweats, migraine, flushings, urticaria, subjective sensations of cold—such as chilliness, asthma, burning, especially of one side of the face or one portion of the body, angioneurotic edema, a tendency to excessive bleeding, exclusive of hemoptysis, subjective sensations of heat.

Lowered Blood-pressure.—Hypotension is an almost constant symptom, becoming more marked as the disease advances. The blood-pressure taken in the reclining position varies much more than in health from that taken in an upright position.

Increased Pulse Frequency.—Acceleration of the pulse rate is an early and most suggestive symptom, noted also in latent cases.

Fever.—Elevation of temperature usually occurs at some time in all tuberculous patients and is frequently produced by exercise, emotion, and oncoming menstruation, and sometimes by digestion. It is chronic as a rule and occurs in the afternoon.

Cough.—While not among the earliest symptoms, nor yet among the most constant, except in the active cases which progress to a frank form, cough

is usually the first symptom that is noted or that draws attention to the lungs; but on the other hand it may excite no suspicion or even attract little notice. The character varies from a dry, hacking cough, or it may be a clearing of the throat, to a loose, productive cough which may even become paroxysmal and cause vomiting.

Expectoration.—Expectoration, although a common is not an early symptom, as a rule regularly appearing later than the cough. It may be unnoticed because the patient swallows it, this being particularly true of children and women. Expectoration is most common in the morning on rising, and next after eating, while in many old cases most of the sputum is raised during the night.

Hemoptysis.—Hemorrhage from the lung occurs in over half the known cases of tuberculosis. It frequently discloses a previously unrecognized tuberculosis by being the first symptom of a hitherto latent form. It may appear in any stage of the disease. The amount of blood lost in twenty-four hours also varies. In half the cases of hemoptysis the sputum is merely streaked with blood. Blood-streaked sputum, however, may be the forerunner of a larger hemorrhage and usually is seen for several days after such larger hemoptysis. In some instances hemoptysis is brought about by overexertion, traumatism, coughing, sneezing, emotion and fatigue, but in most cases it occurs without any apparent exciting cause. The menstrual period and the premenstrual period are the times when women are most liable to hemoptysis. Sometimes in sanatoria epidemics of this symptom occur, as if

the hemorrhages were caused by some germ or intercurrent infection.

Hoarseness.—An alteration of the voice occurs at some time during the course of the disease, although in many cases the voice remains normal. The voice may become weaker, less clear, lower, thicker, hoarse and toneless. A tendency to huskiness, or hoarseness may occur early and be present even in latent cases.

Pain.—Pain occurs at some time in almost, although not in every case of pulmonary tuberculosis, and may be one of the earliest symptoms.

Night-sweats.—Perspiration during the night is a common symptom of pulmonary tuberculosis, and when present always suggests this disease. It does not occur often in the early stages, however, but occasionally may be the earliest symptom. It may occur not only at night but whenever the patient falls asleep, though it should be distinguished from the vasomotor sweating mentioned under "Automatic Disturbance."

Emaciation.—Wasting is the characteristic symptom from which tuberculosis derives its popular names of "consumption" and "phthisis" (the Greek for wasting). Loss of weight may be considered a common symptom and a fairly early one, being present in most latent cases. Occasionally it may be the first and most prominent or even the only symptom.

Dyspnea.—Shortness of breath on exertion is common in tuberculosis, especially in nervous individuals. Except on exertion, however, dyspnea is not a marked symptom in early or chronic or uncomplicated cases.

Diarrhea.—As a symptom diarrhea is common only in advanced cases, but a tendency to diarrhea from slight

causes such as certain articles of food, slight indiscretion in diet, overfeeding, chilling of the abdomen, etc., is frequently met with early in the history of the case.

Neuritis.—Pain, paresthesia, anesthesia, and analgesia may be the result of a neuritis induced by toxic absorption.

Psychical Changes.—The mental conditions most frequently met with in tuberculosis, according to McCarthy, are neurasthenia, a tendency to introspection, together with marked nervous irritability, which leads to a change in the patient's disposition, so that he becomes irritable, "cranky" and often unhappy, mental depression, and impairment of memory. A suspicious mental attitude, mental confusion, and a tendency to delusions also occur in advanced pulmonary tuberculosis.

The *spes phthisica*, the consumptive's hopefulness, so commonly met with, has little or no relation to the real prognosis.

PHYSICAL EXAMINATION.—

Inspection.—The *skin* is often clear and of good color, usually pale, sometimes dull and opaque, giving a muddy complexion, but occasionally there is a general bronzing or patches of light-yellow to pale-brown pigmentation. Flushing is commonly seen and may be unilateral. In many a black line is left when silver is drawn across the face (of course, in the absence of powder). In some cases the blood-vessels show well through the skin. Nearly all show dermatographia.

Eyes.—The conjunctiva are often pale. In about half the patients a rim of sclera shows above or below the cornea. In a smaller number the rim

of the sclera is visible when the patient fixes his eyes on a near object. The eyebrows are unconsciously raised when he opens his eyes widely. In some the palpebral fissure is widened on fixing the gaze and raising the eyebrows. Actual exophthalmos is not infrequent.

The pupils are said to be frequently unequal, that on the affected side being more dilated than the other and more sluggish in its reaction to light. Occasionally they are widely dilated.

The *gums* are often pale. Sometimes a bluish-red line is found along the margin of the gums. A high, angular palate is of common occurrence. The soft palate is often of a pearly, bluish-white tint, and covered with a mucoid moisture.

The *fingers* often have bulbous enlargement at their ends—the so-called clubbed fingers.

Hyperextension of the fingers on the metacarpals or of the terminal on the penultimate phalanges has been found in advanced or rapidly advancing cases.

The *finger-nails* frequently are curved over the ends of the fingers. In a large majority the nails are tricolored, a band of red being at the tip, the lower end, just above the half-moon, being bluish, and the space between being white. This is usually most marked in the thumb-nails.

The *thyroid gland* is frequently enlarged, one of the earliest symptoms of tuberculosis being slight swelling of this gland.

The *shape of the chest* may be normal or it may present the various gradations to the so-called paralytic thorax, which type may exist, however, in the absence of tuberculosis. Ankylosis of the union of the first

rib with the sternum has been noted in a large percentage of cases.

Enlarged venules or capillaries are often present over the anterior walls of the chest, especially along the lower margin of the ribs and to a less extent on the upper portion of the chest, front and back.

Asymmetrical and local alterations of the chest are common, especially in advanced cases. The thorax often becomes flatter on the affected side. Local flattenings and depressions may also occur. A frequent phenomenon is dropping of the acromial end of the clavicle, which normally is higher than the sternal end. The clavicle is usually slightly more prominent on the affected side and the supraclavicular fossa is flattened or even hollowed, marked depressions above and below the clavicle occurring in advanced cases.

Expansion of the chest may be good in early cases, but as a rule retardation and limitation of motion occur very early, frequently confined to the affected side. One of the first physical signs is usually a unilateral limitation or lagging or both. In some patients, according to Brown, a compensatory increase of movement of the lower chest on the affected side seems to occur, and in doubtful cases may aid in localizing the diseased focus. The limitation of motion becomes more marked as the disease advances.

Limited expansion is associated by Bandelier and Raepke with an old lesion, while delayed respiratory movement is regarded as an early symptom and evidence of new involvement. A unilateral drawing in of the apex of the lung may occur. Drawing in of the intercostal spaces, especially of the lower portions of the

chest, often shows the presence of pleural adhesions, while bulging of the intercostal spaces usually indicates an effusion.

Valuable aid may be given in suitable cases by *Litten's diaphragmatic sign*, which consists of a visible wave two inches and a half to two inches and three-quarters in amplitude due to the respiratory movement of the diaphragm. Unilateral diminution of diaphragmatic movement is due to disease of the lung or the pleura and is an early symptom of slight, initial apical disease.

Palpation.—Delay of respiratory movement and deficiency in expansion can best be estimated by palpation combined with inspection.

Vocal fremitus is little if at all changed in many early cases. Normally greater on the right, if it is equal on both sides it is either increased on the left or decreased on the right. When markedly increased it usually indicates consolidation, but in advanced cases it is too variable to be of much diagnostic value.

By palpation we may detect a greater resistance of the chest-wall over the infected area, especially when the finger is used as a pleximeter.

Percussion.—Properly performed, percussion gives valuable information; improperly performed it is of doubtful value for exact work if it does not lead one into serious error. It should be light, especially if the lesions be superficial.

An extremely light and gentle percussion known as threshold percussion is also employed,—one so light that a scarcely perceptible sound is produced. Auscultatory percussion is used in tuberculosis chiefly in outlining the lungs.

The percussion note in a normal chest may be modified by a number of normal conditions, such as posture, atelectasis, or lung-collapse, respiratory movement, the slight decrease of resonance normally present at the right apex, heavy muscles, a thick layer of fat, and local prominence of individual ribs, or of many ribs as in scoliosis.

The first step in percussion, according to many, is the outlining of the lungs and the marking out of the resonant areas above the shoulder-girdle, where the lateral borders of the apical resonance are projected as a broad vertical band extending from the clavicle across the shoulder to the scapula, known as Krönig's "band of resonance."

The condition of the underlying lung is best determined by comparing the percussion notes made with similar technique over the two lungs in corresponding places. Each lung should then be examined separately, beginning below where the normal resonance for that lung exists and percussing upward toward the apex. Slight apical dullness can usually be better detected in this way, especially if both apices be involved.

Where the lesion is very slight the note may be resonant, as the lesion must reach a certain size before it produces any change in the percussion note. Even when consolidation exists, the note may be hyperresonant or tympanitic from lowering of the tension, from compression of the intervening tissue by small foci, and from emphysematous changes—all of which may mask the dullness. The first change indicating tuberculous infiltration is usually, however, a shortening of the duration of the percus-

sion note, accompanied in many cases by a rise in pitch and a diminution of the loudness. Impaired resonance or very slight dullness is also a common early sign. In doubtful cases it is well to percuss the same spot during both inspiration and expiration. According to Aufrecht, in the very early lesions in the apex the note is clearer on inspiration and duller on expiration. As the consolidation increases the percussion note as a rule becomes distinctly dull and may even pass into flatness, although it sometimes may be little changed, even in advanced cases. Even when present, dullness is not necessarily a sign of consolidation, but may be caused by a thickened pleura, pleural effusion, compression of the lung, atelectasis, gangrene, large-sized pulmonary infarction and tumor of the lung.

Hyperresonance or slight tympany may be due to increase of function in the well lung when the other is extensively involved and in the healthy area of the affected lung below the consolidation, to relaxation of the lung-tissue surrounding a tuberculous lesion, and to transmission from underlying bronchi. A tympanitic over-note, on the other hand, may be produced by the presence of a cavity with thick walls or overlaid with condensed lung or much thickened pleura, although such a condition may only give more or less dullness or, if the cavity is deep enough, normal resonance. Small cavities may give no change of note. A clear amphoric note may be heard over a pneumothorax and also over a cavity, usually one that is large, superficial, with smooth walls and having open connection with a bronchus. Over a cavity it is best elicited with the pa-

tient's mouth open. The cracked-pot sound, especially if in the apex, is also produced over a cavity that communicates by a narrow opening with an open bronchus, especially if the chest-wall is thin and yields to the percussion stroke. The sound is elicited by firm percussion during expiration, the patient's mouth being open and the plexor finger remaining in contact with the pleximeter finger instead of rebounding. A cracked-pot sound occasionally can be elicited in health over the chest of a screaming baby and over very thin elastic chests, particularly in children, above a pleural effusion, above a consolidation, in pneumonia before consolidation has taken place, and over a pneumothorax freely communicating with a bronchus. It is oftener absent over cavities than present, according to Landis.

Different kinds of changes in the tympanic note occur in cavities. The sound elicited by percussion over a cavity communicating with a large bronchus is louder, more distinctly tympanitic, and higher in pitch when the mouth is open than when it is closed (*Wintich's sign*.) This change may be distinct in some positions of the body and indistinct or absent in others, when the cavity contains fluid which occludes the communicating bronchus in one position but leaves it open in the other (*interrupted Wintich's sign*.) The note over a cavity is higher in pitch at the end of a deep inspiration than after expiration and may even disappear (*Friedreich's sign*). A cavity containing fluid intermittently will give alternately dullness and tympany when full and empty, respectively. The tympanitic sound elicited over a cavity containing fluid may change its pitch with

change of position in the patient, especially if the cavity be larger in one diameter than in the other (*Gerhardt's sign*). The outlining of the heart is an important use of percussion. Tuberculous changes in the lung frequently alter the outline of the heart, superficial or absolute cardiac dullness becoming displaced toward the affected side, due to shrinking of the lung, and correspondingly diminished on the sound side from compensatory emphysematous changes in the unaffected lung. In muscles that are wasted direct percussion often causes local contraction of the part struck, which rises in little humps, known as myoidena.

Auscultation.—*Local resonance* in health is heard more pronouncedly on the right, in persons with thin chest-walls and in persons with a strong and low-pitched voice. The sounds produced by the spoken voice are heard more distinctly and louder over an area of infiltration and consolidation, vocal resonance being then increased. As the consolidation becomes more marked the sound is transmitted comparatively distinctly to the ear, being known then as bronchophony. When the words are transmitted so distinctly that they seem to come from the chest-wall, we speak of pectoriloquy. This occurs over a cavity communicating with a large bronchus and sometimes over marked consolidation. Amphoric voice is a cavernous voice with metallic echo, heard over a large cavity with thin, smooth walls and over a pneumothorax. Egophony is a tremulous and bleating vocal resonance heard as a rule at the uppermost limit of a pleural effusion and sometimes over an infiltration. "Ninety-nine"

and "one, one, one," are the words usually spoken by the patient. Auscultation of the spoken voice is probably the least valuable physical sign in pulmonary tuberculosis, as it does not always give accurate information. It should nevertheless be practised carefully over the entire chest, as small or deep-seated lesions are often first detected by this means.

The whispered voice, however, is more reliable and should also be very carefully ausculted. The words "one, two, three" are commonly used for whispering. While whispering pectoriloquy is commonly heard over a cavity, it is not pathognomonic and may even be absent over a cavity. It is usually soft, low and blowing when heard over a cavity and harsh, high-pitched and tubular when heard over consolidation.

Vocal resonance is diminished in atelectasis, pleural effusion and thickened pleura. Most patients produce some sounds in their noses which are transmitted to the chest, thus modifying the breath sounds. Others on breathing through the nose may produce a sound in the throat or against the teeth. Hence they should be shown to breathe quietly and deeply.

The whole chest should be gone over carefully first on quiet—then on forced—breathing, no portion of the lung being omitted. As in percussion, symmetrical spots on both sides are compared, after which different portions of the same lung may be compared with one another.

Certain extraneous sounds may prove confusing, such as the humming muscle sound due to contraction of the inspiratory muscles and to shivering, and a venous sound above the clavicle.

The inspiratory murmur is often very faint in the presence of thick chest-walls and on quiet respiration in persons accustomed to a sedentary life, who have never breathed properly.

Normally the breath sounds may be somewhat exaggerated with the expiratory murmur louder, and more prolonged on the right side above the second rib anteriorly and the second vertebral spine posteriorly.

In ausculting the breath sounds we observe the quality and strength of the inspiratory and expiratory murmurs and their relative duration and character. One of the first changes in early pulmonary tuberculosis may be an impure, harsh, hoarse, vesicular sound, often having an uneven or vibratory character. Sometimes, usually in connection with exaggerated vesicular breathing, the inspiratory murmur and occasionally the expiratory murmur, instead of being continuous, is jerky, or wavy, or cog-wheel. When synchronous with cardiac systole, however, and when heard on both sides, it is not an indication of infiltration. Weakened or distant breath sounds, especially when confined to one apex, is very suggestive of tuberculous infiltration. It may, however, be due to limited motion caused by pain, adhesions, feeble musculature or to a thickened pleura or chest-wall, to a constriction of a bronchus by a pressure of large bronchial glands, to effusion, or pneumothorax. Another early sign of infiltration is a prolongation of the expiratory sound with a constant increase in loudness, some harshness, and a slight rise in pitch. Prolongation of expiration with less or no harshness may, however, be heard over healthy lung-tissue, when

it indicates the presence of emphysema. Harsh or puerile breathing is a somewhat later sign and is often heard in the area around a diseased focus. When heard on the unaffected side in advanced cases it often indicates compensatory action of the healthy lung. With increase in consolidation the breath sounds become vesicular, bronchial, and bronchovesicular in character, the type depending upon which element predominates. The expiratory murmur becomes more and more prolonged and harsh while the inspiratory murmur becomes higher in pitch and shorter in duration.

When all vesicular quality is lost and both sounds become harsh and loud we have bronchial breathing, the extent, pitch, and intensity of which varies in accordance with the nature and extent of the lesion. It indicates the presence of consolidation, fibroid tissue, a dilated bronchus, or a cavity communicating with a bronchus, and may also be heard above a pleural effusion. Over a cavity bronchial breathing often becomes lower in pitch and has a more hollow quality, being then known as cavernous breathing. When the latter has a metallic quality it is called amphoric breathing and usually indicates a comparatively large, smooth-walled cavity of regular shape and communicating with a bronchus through a small opening. It is also heard over a pneumothorax communicating with a bronchus. Another sign indicating the presence of a cavity, according to many observers, is metamorphosing breathing in which the breath sounds suddenly change during inspiration from vesicular to bronchial or *vice versa*.

In addition to changes in the breath sounds one hears on ausculting the chest certain adventitious signs. As a rule they are due to disease of the lung or pleura, but a few may occur accidentally or independent of disease and thus cause confusion. The latter are caused by hair on the chest, a very dry skin, a stethoscope not evenly or firmly applied, firm pressure of the stethoscope against the chest in very stout or very muscular individuals, contraction of the muscle fibers of the muscles and tendons of the head and shoulder-girdle, friction between the shoulder-blade and thorax, crackles produced in the shoulder-joint, sounds produced by the act of swallowing, and to a less extent by ascending sounds from the esophagus and by similar noises caused by movements of the stomach and intestines.

Râles are usually heard in acute and in active tuberculosis of the lungs and in the more advanced cases. In incipient cases they are rarely heard on quiet breathing and as a rule only during forced inspiration following cough, properly performed. It is usual to have the patient cough with some force but as noiselessly as possible before taking a full, fairly rapid inspiration. Babcock has the patient cough at the end of inspiration. According to Brown, the absence of râles cannot be confirmed unless the patient gives two slight coughs at the end of and as part of the expiration and then takes a full inspiration. Similarly, Bandelier and Roepke meet many cases in which even numerous râles can only be detected after the patient has coughed some five or six times, one after another, without inspiration between, like the cough of whooping-cough, and then takes a

deep breath. In some instances râles are said to be heard only when the patient is in a reclining position. Pottinger has been able to elicit râles which were not present in ordinary respiration by having the patient lie on the well side, thus forcing the diseased lung to greater activity. It is said that râles are more apt to be heard early in the morning.

In examining for râles the patient should be ausculted first on quiet breathing, then on forced breathing, and finally after coughing.

In early cases of pulmonary tuberculosis râles often occur only during inspiration following a cough, as previously stated, at times only at the end of inspiration, and occasionally only during expiration after a cough. The earliest râles heard are usually a few fine crackles limited to one spot, most frequently in the apex, persistent after cough, and not transitory. In some cases a wheeze or whine is heard. A few fine persistent râles may be present.

As the disease progresses râles are often heard even on quiet breathing. A few fine moist râles are heard both during inspiration and expiration over a limited area, most commonly above or below the clavicle, slightly more often on the right side, and frequently in the supraspinous area. Later the râles become more diffused and more numerous and then medium sized and moderately coarse. With rapidly advancing softening and with cavity formation the râles become large and moist. Over a small cavity the râles most frequently have a sharp-ringing, metallic character, while over large cavities they are usually coarse and bubbling. In old cavities they may appear as hisses,

creaks, and sonorous and sibilant rhonchi. A localized click, squeak, or croak is regarded by Pottenger as suspicious of cavity formation. Resonant râles occur both over cavities and where none exist.

Gurgling râles may indicate either cavity formation or bronchial dilatation. Post-tussive suction, a peculiar high-pitched, sucking sound occurring during the first part of inspiration following cough, is heard not uncommonly over cavities, according to Brown, but also does occur where no other sign of cavity exists. Metallic tinkling is of rare occurrence and is found only in large cavities and pneumothorax. Persistence and constancy as to character and location are characteristic of râles in pulmonary tuberculosis, their position and type changing only as the disease progresses or retrogrades.

One must be careful to distinguish true râles from the innumerable sibilant and sonorous râles of asthma, and pleuritic friction sounds.

With the exception of these crepitations, pleuritic friction is rare in early stages. While not common, isolated pleuritic friction sounds over an apex are suggestive of tuberculous apical pleurisy. Thin or medium-sized frictions are frequently found at the bases posteriorly and point to an old pleurisy. This is not at all uncommon when tuberculosis is present at the corresponding apex.

Undue transmission of heart sounds to the right apex so that they are distinctly audible there, is a valuable sign of infiltration of the underlying lung, if increased cardiac action through nervousness or through cardiac disease can be excluded. It is of no less value when heard at the left

apex and at times may occur over the small areas of the lung, especially in the base behind.

Some accentuation of the second pulmonic sound is frequent in advanced but uncommon in early stages.

At times what is known as the subclavian murmur is heard over the subclavian artery more often above the clavicle than below it and either during both inspiration and expiration or partly in each. Forcible inspiration increases it when just audible. It denotes an inflammatory pleuritic process resulting in adhesion including the subclavian artery. It is most frequently found with apical tuberculosis and, owing to the probability of chronic pleurisy being tuberculosis, this sign has a suggestive significance.

X-ray Examination.—An X-ray picture, taken and interpreted by an expert röntgenologist, is often of confirmatory value. It seldom shows early changes, gives no information as to the specific nature and activity of the disease, and is subject to errors of interpretation. It frequently aids in doubtful though not early cases, however, and in differential diagnosis, and gives valuable information in regard to the position and condition of the neighboring organs.

The Blood.—The blood-picture in pulmonary tuberculosis is not constant but varies with the stage, the acuteness, the progress, the complications, the climate and the treatment. The earliest and most constant change is a reduction of the color-index—a condition of chlorosis. This is common in latent cases. The *hemoglobin* is usually more or less reduced but may show a percentage above normal.

The *red blood-cells* are usually diminished but seldom in proportion to the hemoglobin, rarely falling under 3,000,000 in uncomplicated cases. They not uncommonly are increased above normal, especially in patients undergoing treatment.

The *leucocytes* in incipient and moderately advanced cases are at times somewhat reduced in number, but as a rule are fairly normal. In the far-advanced stage they are usually increased in number, especially during softening or cavity formation. The differential count bears a relation to the stage and progress of the disease and the amount of lung involvement. The *polymorphonuclear neutrophiles* are increased as the disease advances and the involvement extends as the patient grows worse, and are decreased as the patient improves. According to most observers, in favorable and improving cases there is a decrease, and in unfavorable cases an increase, in the number of these neutrophilic cells with one and two nuclei at the expense of those with three, four, and five nuclei, the increase being greater the more severe the case, although the writer's figures showed the reverse. The *lymphocytes* are reduced in number the more advanced the disease and the greater the amount of lung-tissue involved and are increased as the patient improves and diminish as he gets worse. The *mononuclear* and *transitional cells* are unaffected by the stage, extent or progress of the disease. The proportion of *eosinophiles*, according to a number of observers, diminishes as the patients grow worse and increases as they improve, but was not affected in the writer's cases.

The *clotting-time* of the blood was shortened in the one hundred cases examined by the writer and in Vierrondt's cases, but was normal in twelve cases tested by Addis.

Sputum; Microscopical Examination of.—In every case suspected to be one of pulmonary tuberculosis the morning sputum coughed up from the lung should be examined microscopically, repeatedly if with negative results. Even if the patient states he does not expectorate, one should examine a sputum obtained by clearing his throat in the morning, or after meals, or a swab of the throat, or a slide on which the patient has coughed for eight or ten mornings. Little flecks of pus or cheesy particles from five or six different parts of the specimen, where present, or, if absent from the thickest and most purulent part of the specimen, are smeared on a glass slide and, after fixing by being passed through a flame, stained for one to five minutes with carbol-fuchsin which is brought just to a boil. The specimen is then decolorized by immersion for five minutes in a 20 per cent. solution of sulphuric acid or for half a minute in spirit of nitrous ether, washed in water (if not sufficiently decolorized again subjected to this treatment), and counterstained with concentrated aqueous methylene-blue solution or Löffler's alkaline methylene-blue. When tubercle bacilli are few, the sputum may be treated with antiformin and the centrifugated sediment examined.

While the presence of tubercle bacilli in the sputum is diagnostic of tuberculosis, their absence even on repeated examination does not exclude it, especially in early cases, as they are found only in a small pro-

portion of incipient cases. Elastic fibers are suggestive of tuberculosis and usually indicate extensive destruction of pulmonary, bronchial, or tracheal tissue. Secondary organisms from the middle of washed sputum examined within fifteen minutes of its expectoration may indicate secondary infection if present after repeated examinations.

DIAGNOSIS.—In making a diagnosis of tuberculosis, especially in difficult cases, one must give proper weight to many points in the history and physical examination, as well as call to aid X-ray examination and various laboratory and other tests. A possible source of infection, predisposing factors, suspicious symptoms as given above, especially hemoptysis, cough, and pleurisy, must all be taken into consideration. A positive diagnosis cannot properly be made from symptoms alone, but even the absence of demonstrable physical signs will not be sufficient to absolutely eliminate pulmonary tuberculosis when the symptoms are very suggestive. Nor is the presence of slight or indefinite physical signs sufficient to establish a diagnosis in the absence of symptoms. Definite physical signs are usually diagnostic. The combination, however, of both signs and symptoms, even though one or both may be slight, is the surest guide. The presence of tubercle bacilli in the sputum decides the diagnosis, but their absence is of no significance. As already stated, X-ray examination may be helpful.

The *complement-fixation test* as now perfected is of distinct value.

Tuberculin, usually in the form of old tuberculin, is used for diagnosis, administered beneath the skin, on the

abraded skin, on the unbroken skin, and in the eye. The *ophthalmotuberculin test* consists of introducing a drop of a 1 per cent. solution into the conjunctival sac of one eye, being followed by a conjunctivitis when positive. It is generally regarded as too dangerous. The *subcutaneous test* is considered the most reliable, but the writer regards it also as too dangerous.

The other three methods of testing with tuberculin, however, are safe, although less reliable than the subcutaneous test.

In the cutaneous or *von Pirquet test* the skin of the forearm is scarified through a drop of old tuberculin, while in the more accurate intracutaneous test the tuberculin is injected into the skin itself just below the epidermis. A positive reaction is shown by the formation of an areola, induration or papule at the site of inoculation in from twenty-four to forty-eight hours. A negative result usually indicates absence of tuberculosis. A positive reaction shows that the body has at some time and in some way been infected with tubercle bacilli; it indicates tuberculous infection but not necessarily tuberculous disease. Its disadvantage is that it may be present in apparently healthy persons, but this may prove in some ways an advantage in revealing latent tuberculosis. The *percutaneous* or *Moro test*, which is of least value, consists of rubbing into an area of the skin about 10 square inches with moderate pressure for one minute a piece of 50 per cent. tuberculin ointment the size of a pea. When positive, red points or confluent red spots or even small papules appear in twenty-four to forty-eight hours.

DIFFERENTIAL DIAGNOSIS.

—In every doubtful case of illness tuberculosis must be borne in mind as a possibility. Of the many diseases and conditions that may be mistaken for or be simulated by tuberculosis, lack of space prevents more than their mere mention. Among the latter are chlorosis, debility, nervous dyspepsia, Graves's disease, autonomic ataxia, malaria, typhoid fever, bronchitis, influenza, pleurisy, asthma and pneumonia, both acute and chronic. Among the former may be mentioned general diseases such as concealed sepsis, including a perinephritic or prostatic abscess, a suppurating tonsil, pyelitis, a mild chronic appendicitis or salpingitis, endocarditis, pyorrhea alveolaris, pernicious anemia, Graves's disease, myocarditis, and cardiac decompensation. Chest conditions simulating pulmonary phthisis are: influenza, bronchiectasis, pleurisy with effusion, and abscess, gangrene, syphilis, tumor, parasitic and fungous disease, actinomycosis, hydatid disease, and infarct of the lung, pneumoconiosis, collapse and induration of the lung, and pneumothorax.

ETIOLOGY AND PATHOGENESIS.

—Tuberculosis is the most widespread of all diseases, from one-seventh to one-tenth of all deaths and an enormous proportion of invalidism being due to it; from 50 to 70 per cent. for all ages representing the approximate frequency of tuberculous infection. This infection probably occurs usually during infancy and childhood. The tubercle bacillus may enter the mouth from contaminated fingers, lips, toys, eating utensils, floor, furniture, clothing, handkerchiefs, bed-clothing, towels, food,

animals, etc., or enter the air-passages with contaminated dust, air, or spray. Infection through the skin is rare. A frequent method of entrance, especially in children, is by way of the intestinal tract, either in infected milk or other food, or in swallowing with the saliva or food bacilli which have entered the mouth from other objects, the bacilli passing through the intestinal wall by way of the lacteals and thoracic duct into the blood, being sometimes arrested in the mesenteric nodes. On their way down, the organisms may enter the tonsil and thence find lodgement in the lymphatic glands draining it. In the majority of cases the respiratory tract is probably the route of infection. The bacilli entering the air-passages may reach the lung directly or by way of the lymphatics or blood-stream after passing through the mucous membrane of the nose, mouth, or throat. The predisposition of the lungs is in many cases due in part to their peculiar arrangement. Not only do the inspiratory air-currents bring the bacilli to the smallest bronchioles, but the whole volume of venous blood with the lymph from all the lymphatic channels is brought to the lungs, where the slowing of the blood-stream in the pulmonary capillaries favors the deposition there of any bacilli in the circulation.

The presence in the body of the tubercle bacillus, with its foreign toxic nucleoproteids, fats, and phosphorus, stimulates automatically the protective and health-preserving and health-restoring mechanism of the body, with which all animals are endowed.

The conflict between the body and the bacillus is probably influenced by

the number and virulence of the latter and by the power of resistance possessed by the former. Inasmuch as only a portion of those in whom tuberculous infection occurs develop tuberculous disease, it is customary to assume that a predisposition exists in those who succumb.

The causes of a subnormal resistance to tuberculosis are either natural or acquired. Among the natural causes are race, a defect in vital energy, a deficient functional activity of the adrenal system, a deficiency in the tissues of mineral salts, constitutional weakness or mal-development—the *habitus phthisicus*—puberty, menopause, menstruation, pregnancy, and lactation are other natural causes of subnormal resistance.

Acquired predisposition results from local or general influences which lower the powers of resistance of the whole organism or of individual organs and increase the probability of infection on exposure by diminishing the natural resistance of the normal cell. Among the general diseases thus acting are diabetes, syphilis, and the general debility following severe infections, such as typhoid fever, rheumatic fever and malaria, chronic gastrointestinal disease, especially chronic gonorrhea, nephritis, carcinoma, chronic heart disease with cardiac or pulmonary stenosis. Other depressive influences that either predispose to tuberculous infection or else so lower the resistive power that a latent lesion previously held in check becomes active are certain traumata accompanied by surgical shock, such as are produced by falls, railway accidents, severe labor, and operations, and various psychic fac-

tors, such as grief, disappointment, fear, shame, anxiety, shock, religious gloom and terror, and psychical depression, and other conditions, such as unfavorable climate and climatic changes, puerperal complications.

Another group of causes which may be included under the head of privation are: want of proper blood, of air, want of light, want of cleanliness, want of clothing, want of shelter, want of enjoyment.

Under the head of excesses are included dissipation, particularly sexual excesses, overeating and overdrinking, overexercise, exhausting or un-resting labor, physical or mental, leading to bodily and mental overstrain and overfatigue, prolonged lactation, lactation continued during pregnancy, too frequent and rapidly succeeding pregnancies, and violent and consuming emotions, rage, jealousy, greed, inordinate ambition, and the like. In addition to the conditions producing predisposition to tuberculosis, there are many conditions that act locally in weakening the resistance of the lungs. Among them are slight mechanical injuries to the smallest bronchial tubes from inhalation of particles of mineral, metallic, vegetable or animal dust; chemical injuries from substances such as corrosive vapors and gases; and gross traumatic injuries from direct or indirect violence, such as punctures, shots, blows, falls, crushing, all of which injuries may also bring into activity a latent focus; and various catarrhal and inflammatory diseases affecting the smaller respiratory passages, and the lungs, such as lobar pneumonia and bronchopneumonia, influenza, measles, scarlet fever, whooping-cough, variola, diphtheria,

tonsillitis, and bronchitis. These diseases also frequently develop a latent tuberculosis or favor a new infection. While primary pleurisy is so frequently a symptom of tuberculosis, being often the first symptom of an hitherto quiescent tuberculosis, secondary pleurisies due to trauma, pneumonia, and other respiratory diseases may have a predisposing influence, especially when pleural adhesions hamper respiratory movement and thus render the expulsion of intruding bacilli more difficult and precipitate their development.

PATHOLOGY.—The living tubercle bacilli, on entering the body, multiply and as a result of their mechanical irritation as foreign bodies stimulate the tissues surrounding them to an exuberant growth having a reparative character. This consists in a new formation of epithelioid cells, produced chiefly from connective-tissue cells, but also from the epithelial and endothelial cells of the capillaries. At the same time the endotoxins of the tubercle bacilli and the products of their disintegration evoke an inflammatory reaction, characterized by the migration in numbers of leucocytes, mostly lymphocytes, from the capillaries of the infected focus to the periphery of the newly formed nodule and in many cases between the epithelioid cells. A new cell is also formed from the great enlargement of an epithelioid cell and the multiplication of its nucleus, known as a giant cell. With the migration of the leucocytes occurs a more or less serous exudation into the newly formed nodule, the amount of coagulable inflammatory exudate—fibrin—being subject to a great variation and dependent on the degree of injury to

the blood-vessels, which in turn may be determined by the number, relation, virulence and location of the invading bacilli. It is believed that the slower the development of the changes, due to a fewer number or relatively low virulence of the bacilli or to a relatively greater resistance of the tissues, the more marked will be the proliferative over the inflammatory and exudative processes, and *vice versa*. The proliferating cells force apart and open up the fibers of the original connective tissue, which together with long interlacing processes sent out by the epithelioid cells, especially the giant cells, become the reticulum of the tubercle, being as a rule most apparent at the margins. The pressure on the peripheral layers exercised by the cell proliferation causes them to be densely heaped up and flattened, thus tending to encapsulate the tubercle. The included vessels are destroyed by coagulation and no new vessels are formed in the tubercle.

As seen by the naked eye the tubercle forms a little, gray, transparent granule somewhat smaller than a millet-seed.

In the center of the tubercle there begins a process of coagulation necrosis in the cells, affecting first the leucocytic elements and then the epithelioid cells. This proceeds outward, until the tubercle is a uniform mass of *débris* inclosing fat globules in which tubercle bacilli are still abundant, presenting microscopically a yellow color.

Several small tubercles at the same point may caseate in their center, join together and form a caseous nodule of varying size, and cheesy masses may be formed by an aggre-

gation of such nodules, usually in small groups of lobules, occasionally in an entire lobe, or even the greater part of a lung.

These cheesy masses may undergo softening, fibroid limitation (encapsulation), or calcification, their further and ultimate fate depending upon the resistive power of the patient.

Suppuration or softening is largely the result of an infection with pus organisms, but may occur without their co-operation. When the caseous contents of a tubercle or a caseous nodule softens and breaks through into a bronchus, a small cavity is formed and the previously closed tuberculosis has become open, permitting the escape of secretion containing bacilli into the bronchial tubes, and so externally. This is usually the first step in the wider involvement of the lung, violent respiratory movements and cough aided by gravity tending to distribute the bacilli back into the previously uninfected bronchi and thence into the finest bronchioles and the associated air-vesicles, where new tuberculous lesions result. The disease may also spread by continuity, or through the lymphatics or blood-vessels.

A tubercle heals in several ways. The epithelioid cells may exhibit prolongation into spindle-shaped fibroblasts which proceed to form connective tissue that gradually penetrates the whole tubercle, converting it into fibrous tissue. Diffuse connective-tissue overgrowth may render large parts of the lung, especially at the apices, airless and quite indurated with fibrous infiltration. This is known as **fibroid phthisis**, and has a very chronic course and a rela-

tively favorable termination. Instead of the replacing connective tissue being formed by the tuberculous cells themselves, it is more commonly derived from fibrous tissue which is always formed around a tuberculous process, and restrains and limits the spread of the disease. The caseous contents of a tubercle may remain encapsulated in the connective tissue and be absorbed or wholly or partly calcified. By the formation of granulation tissue an empty cavity may become gradually smaller and by cicatricial contraction may entirely heal. If the cavity is too large, or the contraction prevented by adhesions, it may be healed by the formation of a firm, smooth, pyogenic membrane.

PROGNOSIS.—Prognosis in tuberculosis depends upon a correct estimate of the character of the tissue-soil, and the virulence of the infection, the nature and extent of the disease, and upon the proper management of the patient. In acute miliary tuberculosis and in florid phthisis it is invariably bad, as both go on to a fatal termination. Prognosis even in chronic cases had best be guarded and indicate merely the probabilities. Favorable circumstances are a well-built thorax, a good constitution, good general health, good digestion and appetite, infrequent pulse, normal or high blood-pressure, absence of fever, bad previous and good present and future environment, methodical habits, tractability, self-control, resolution, perseverance, an early diagnosis, gain of weight on ordinary diet, gradual and continuous improvement of cough, progressive diminution of the sputum, increase in hemoglobin, red blood-cells, and in the percentage of lymphocytes, and possibly of poly-

morphonuclear neutrophiles containing three or more nuclei, incipency, limited lesion with disease of some duration, a complete and constant absence of all râles after coughing, a gradual change from purulent to a mucoid sputum, absence of tubercle bacilli in the sputum, arthritis, rheumatism, gout, mitral stenosis, slight emphysema, favorable financial condition, and skilled management of the treatment.

Unfavorable circumstances are: phthisical build, undermining of strength by disease, excesses, alcoholism, bodily and mental overstrain, frequent pregnancies, difficult labors, grief, privation, and other factors lowering the resistance and nutrition, chronic affections of the digestive and assimilative organs, failing appetite, progressive loss of weight, easily accelerated pulse, constantly frequent pulse, fever unaffected by absolute rest, high fever, copious and frequent hemoptysis, the presence in the sputum of numerous short tubercle bacilli, especially when in clumps, and of elastic fibers, increasing years after the age of twenty.

A tardy diagnosis, an acute onset with extensive or marked physical signs, loss of weight approximating one-quarter of the body weight and especially one-third, a steady loss of weight, strong antipathies to the proper food, marked cachexia, cyanosis of the lips, face, and extremities and following hemoptysis, long-continued amenorrhea, albuminuria if more than transient, an increase in the proportion of polymorphonuclear leucocytes and possibly in those with one and two nuclei, primary infections at the base, advanced disease, scattered foci, an extensive lesion of

short duration, severe symptoms occurring with slight physical signs, a lesion of wide extent, large cavities, excessive fibrosis in both lungs, a sudden change from a purulent to a frothy, watery sputum, the occurrence of lung stones, good previous environment, bad present and future environment, poor financial condition, unskilled management, and the occurrence of any complication, especially tuberculous laryngitis, hemorrhagic pleural effusion, empyema, pneumothorax, diabetes mellitus, pulmonary stenosis, pulmonary gangrene, lardaceous disease, tuberculous stomatitis or pharyngitis, edema, melancholia, insanity, syphilis, bronchiectasis, persistent anemia, chronic peritonitis and weak heart—all influence more or less effectively the issue.

TREATMENT.—The chief aim in treating a patient with tuberculosis is to aid and increase the natural defensive powers of the individual, reinforcing his vital energy and rendering his tissue-soil as unfavorable as possible for the growth and spread of the tubercle bacillus. There are many ways in which we can render assistance, the most essential and most important being to bring the patient's general health to the highest possible standard by attention to general hygiene and nutrition. This is the *sine qua non* of tuberculosis therapy, and is considered by many, erroneously in the writer's opinion, to be the whole treatment. That it must be the foundation of every method employed, no one can dispute.

Fresh Air.—Fresh air by day and by night is the most important factor in recovery. At home the patient can get fresh air on a porch or ver-

anda, in a wall-tent or a specially constructed, well-ventilated tent, each having a wooden floor, in a yard, on a balcony, on a roof, or in a room with thorough ventilation. In the last, bed-patients can utilize window tents or have a bed whose end projects out the window.

In sanatoria, patients also use rooms with thorough ventilation, open halls, piazzas, porches, verandas, bungaloes, lean-tos, huts, cabins, kiosks, shacks, sun-traps, properly ventilated tents, chalets, and shelters. Change of climate and environment, irrespective of their character, often proves beneficial. In general that climate is suitable for the individual patient that increases the activity of his digestive functions and thus stimulates nutrition, improves the tone of his nervous and circulatory systems, either by invigoration or protection, raises his vital energy or resistive power, lessens his exposure to secondary infections, and in certain cases has a palliative influence on distressing symptoms. As a rule the young, the robust or fairly robust, the patients with early and active lesions, large eaters, do best in a cold, dry, variable and hence invigorating climate. Older, weakened, more or less delicate persons need most frequently a climate of protection, which is warm, moderately dry, equable, sheltered, and of lower altitude.

Rest.—In all acute and subacute cases this is important. Acute and toxic cases require absolute rest in bed. Absolute rest is also best at the beginning of treatment in every case and is desirable for an hour or two after the mid-day meal in the majority of patients taking the chair cure. In the rest cure or chair cure, famil-

iarly spoken of as "the cure," the patient reclines in a comfortable reclining or steamer chair, preferably not of canvas, and not in a hammock, as the last two tend to compress the thorax. The chair cure is usually kept up strictly for at least two months in most cases and thereafter when the patient is not exercising or resting in bed. Slightly febrile or anemic patients, those much reduced in weight, with cardiac decompensation, with blood-streaked sputum, should rest the whole day. Febrile patients in the earlier stages of the disease, should spend 6 to 8 hours in their chairs at first, the time gradually being reduced as their condition improves.

Exercise.—Febrile and toxic patients in bed at absolute rest should be spared every unnecessary movement. After the temperature has remained normal for a week and the disease is quiescent, the patient may begin active exercise in the form of a short walk on the level in the open air in the morning at a slow rate, about two miles an hour, with frequent pauses for rest.

The physician must carefully supervise the exercise and see that it does not produce fatigue, fever, rapid pulse or signs of reaction, intoxication, or inactivity. After a patient has walked one-quarter to one-half hour on the level, he may attempt an incline, taking the ascent at the beginning of his walk while fresh. He should always walk with an upright carriage and breathe through his nose. It is important always to finish the walk in time to rest for a quarter to half an hour before meals. A patient who bears well long walks, especially up hill, can be put on light work,

which under favorable conditions can be gradually increased, until he is accomplishing the amount of work he was accustomed to doing in health. Carriage and automobile riding, and boating are permitted for definitely regulated periods when the patient is able to walk but a few minutes. As the power for work returns, mild sports, such as croquet, fishing and hunting, when not entailing too much exercise, skating by those proficient, gentle or light calisthenics, may be permitted. When the disease has been arrested for some months, golf (without the full swing), gentle bicycle riding on the level, rowing, paddling, skeeing, snow-shoeing, swimming in great moderation, sledging, tobogganning, and horseback riding may be indulged in, all in moderation. Violent sports, such as tennis, racquets, foot-ball, base-ball, hand-ball, hockey, lacrosse, polo, fox-hunting, wrestling, boxing, gymnastics, bowling, and the like, should be avoided, owing to the danger of over-exertion with its tendency to causing a relapse. The contraindications to active exercise are fewer, rapid pulse not due to lack of exercise or a recent acute attack, blood in the sputum, and loss of weight.

Respiratory Exercises.—The simplest forms of respiratory exercise are simple deep breathing and sighing; or, a slow and steady inspiration through the nose, without overdistention of the lungs, may be followed by a rapid, jerky expiration. In addition the arms may be raised during inspiration and lowered during expiration, toward the end of which they may press upon the chest. The object is to increase respiratory capacity. Another method of breathing

with an entirely different object is the impeding of inspiration by means of Kuhn's lung suction mark, or by having the patient inhale through a quill toothpick held between the lips or through a small aperture made by the lips or through compressed nostrils, or through a partially closed glottis. This produces negative pressure in the thorax, causing marked aspiration of blood from the right side of the heart into the lungs, producing a passive (Bier's) hyperemia, and at the same time promoting the circulation of lymph. The lower oxygen tension affects the blood-producing apparatus, causing an increase in hemoglobin and in the number of red and white blood-corpuscles.

Diet.—Suitable nourishment is essential to recovery, being equally as important as, if not of greater importance than, fresh air.

The most approved diet consists of three regular meals of ordinary good, plain, wholesome, varied mixed food with lunches between consisting of eggs, milk, beef-juice, koumyss, kefir, broth or some prepared food. The lunches may be dispensed with when a patient has attained the normal weight for his height and age, unless he feels the need of them. Meat, preferably beef and mutton, especially the former, and best rare, is probably the most important food, and at first should be eaten three times a day. Fresh eggs are also important and can be taken raw or cooked, up to six a day. Pure milk is also valuable, in daily quantities of three or four pints, but drunk slowly. Butter, bread, cheese, vegetables of all sorts, salads, and fresh and cooked fruits complete the dietary. The meals should be chosen with care as

to variety, tastefully and appetizingly prepared, and served attractively, punctually, and quickly.

The patient should eat slowly and masticate well, for which his teeth must be put and kept in good condition. In a general way he should eat just enough food to enable him to gain on an average one to two pounds per week until the normal weight for his age and height are reached and then just sufficient to maintain this. Many patients, however, do not gain on this ordinary diet or cannot eat or digest it, and require special diets or extra food. The best diet in the writer's experience is two to two and a half or three pounds of beef a day caten in the form of rare beefsteak, rare roast beef, rare hamburger steak or meat balls, rare-meat loaf, raw meat chopped up with onions, celery, green peppers, etc., and raw scraped beef sandwiches. Half an hour before each meal the patient should drink one cup of hot water for each half-pound of meat to be taken. Carbohydrates must usually be excluded from this diet, as they usually interfere with the ability to ingest such large quantities of meat, but green vegetables and salads may be allowed. In sur-alimentation we may employ zomotherapy in the form of meat-juice; also cream, butter, cod-liver oil and olive oil; eggs—cooked or raw, plain or in milk or as egg-nog, or as an egg-lemonade, or taken as a raw oyster with lemon-juice or catsup, whole, or just the yolk or the white; milk—raw or boiled, hot or cold, in large or small quantities, plain or with the addition of table salt, sodium citrate, lime-water, bicarbonate of soda, malted milk, barley-water, or oatmeal-water; one of the prepared foods, car-

bonated water, a little tea, coffee or brandy, peptonizing or pancreatizing powders, or lactic acid bacilli, or in the form of buttermilk or koumyss, kefir, curds, or whey; and various prepared proprietary foods. One must be careful to avoid disturbing the digestion or injuring the kidneys.

Clothing.—The clothing should be of open texture, light, loose, not oppressive, and suited to the climate and season. Underwear and socks or stockings of finely combed wool or of silk or of a mixture of wool and cotton should be worn winter and summer, as wool and silk are non-conductors of heat, keeping in the body heat in winter and keeping out the overheated air in summer; at the same time by absorbing moisture in the fibers as well as between them they can absorb ordinary perspiration without becoming damp and also allow it to evaporate slowly without chilling the skin. Corsets may fit tightly around the hips but should be loose about the chest. The day clothing should be removed and aired at night and as little clothing as possible worn in bed.

Bathing.—For the purpose of removing the perspiration, grease, scurf and epidermic scales, and thus promoting physiological breathing, excretion and relieving the lungs of part of their work, the patient should take a cleansing bath with soap and hot water of a temperature of 90° to 95° F. once or twice a week, for 5 to 15 minutes, followed by a brief cool douche, sponge or abluion of 68° to 80° F. The stimulating or hardening both consists in the application of cold water followed by dry friction and can be taken in a number of forms, the type, temperature and

duration being suited to the individual patient. Every tuberculous patient can take some form of this cold stimulating bath, which is best taken immediately upon rising in the morning. Its benefit comes from the reaction following it, which is promoted by a brisk rubbing with a dry towel after the bath until the skin becomes pink and warm and also, in those weak or unaccustomed to cold bathing, by supplying heat to the body before the application of cold by means of a hot tub-bath or hot sponge-bath of 100° F. for 3 to 5 minutes or of a brisk dry rub or exercise. A cloth wrung out of cold or iced water and frequently changed should be applied to the head, or the head should be frequently bathed in cold water, during the cold procedure. The mildest form and that most easily borne is the cold ablution, in which water of a constant temperature from 85° to 65° F. or less, not lowered during the bath, is rubbed with friction on the skin with the hand or with a rough wash-cloth or bath-glove—not with a soft sponge. The duration may vary from a couple of seconds to a minute or two. The patient may stand in a dry tub or in 12 inches of water at 100° F. Another form of the stimulating bath is the cold full bath in which the patient jumps into a tub of water at a temperature of from 85° to 65° F. or colder, and remains in for several seconds, exercising, all the while, and then jumps out. In the cold shower, which may be of the same temperature and of five, ten or fifteen seconds' duration, the mechanical stimulation to the skin caused by the force of the water promotes the reaction. For this the pressure of the water must be not less

than fifteen pounds to the square inch, which is not often obtained in a private house.

Chest Compress.—Hydrotherapy is applied directly to the chest in the form of the stimulating chest compress to increase the circulation in the lungs, including active hyperemia, to quiet the movements of the chest and therefore of the diseased lungs, to tranquilize the whole organism, and produce sleep, lessen cough and irritation, and alleviate pains in the chest and side. The Winternitz cross-binder consists of an 8-inch linen or muslin bandage about 7 or 8 yards long, well wrung out of cold water and, beginning at the right axilla, carried over the left shoulder across the back to the point of origin, then brought forward across the front of the chest to the left axilla and finally transversely across the back and over the right shoulder, terminating on the front of the chest. A dry flannel bandage is applied similarly accurately covering the first at every point. This is left on all night but may also be used during the day, being then reapplied after drying and rubbing the skin into a glow every 3 or 4 hours for bed patients and every 5 or 6 hours in febrile cases. Instead, napkins or towels or a jacket made of three or four thicknesses of old linen, made to fit close up about the neck and to come down to the lower edge of the ribs, wrung out of cold water, may be applied to the chest and covered by flannel.

Tuberculins and Sera.—The object of specific treatment is to produce active or passive immunity. By the administration of dead tubercle bacilli or their products, known as tuberculin, the affected organism is stimu-

lated to prepare actively the specific protective bodies, which it has not been able of itself to form in sufficient quantities. The administration of sera, instead of imitating the natural process of self-healing, supplies to the affected organism ready-made protective materials that have been formed in other organisms. Among the sera used for the production of passive immunity are **Maragliano's serum**, **Marmorek's antitubercular serum**, and **Bruchetinni's serum-vaccine and curative serum**. Their value is regarded as doubtful and certainly far below that of the active immunizing tuberculins. The tuberculins most commonly used are **Koch's old tuberculin (O. T.)**, **tuberculin Ruckstand (T. R.)**, **bacilli emulsion (B. E.)**, **bouillon filtrate (B. F.)**. Many other forms of tuberculin have been and are used and may possibly be of equal, greater or less value than those mentioned, but their use is more restrictive. Each form has its advocates, but many observers believe that the majority of tuberculins used clinically are of equal value. The writer prefers tuberculin Ruckstand.

Tuberculin may be administered either hypodermically or by mouth on an empty stomach at least half an hour before a meal. Patients differ so in their sensitiveness to tuberculin that one may require a dose one thousand or one million times that required by another patient who may be apparently of the same type. White and Williams and the writer endeavor to determine the exact dose for the individual patient by testing for his hypersensitiveness to definite amounts of tuberculin, the former using the *von Pirquet cutaneous test* and the writer the *intracutaneous test*. With

out this guide there is no way of determining with any degree of accuracy the proper dose for the person that has never taken tuberculin, the initial dose being always fixed arbitrarily or guessed at. Most every one is in favor of beginning with a minute dose, but there is a great difference of opinion as to what constitutes a minute dose, some giving a tenth and others a hundred-thousandth of a milligram. In order to give an amount that will probably do no harm, the writer usually begins with one millionth of a milligram, when no test is made for hypersensitiveness. Every dose after the first is determined by the effect produced by the preceding dose, which may be seen in the opsonic curve, leucocytic count, leucocytic differential picture, Arneth count, temperature curve, subjective and objective symptoms and physical signs.

For practical purposes sufficient information can be gained by a careful study of the clinical symptoms and physical signs. A dose that is followed the same day or the next day by a favorable reaction, such as a feeling of well-being, rise of spirits, increase of appetite, fall of an elevated temperature to normal, or reduction of the extent of the daily fluctuation of the temperature, is the appropriate dose for that patient and should be maintained so long as it provokes such favorable phenomena. Nor should any change be made in the dose when it is followed by a very slight unfavorable reaction that lasts but a few hours, or at most a day, and is then followed by an improvement in the symptoms or general condition. The dose should always be reduced if it causes symptoms of an

unfavorable reaction, such as rise of temperature, increase of symptoms, malaise, anorexia, pains, loss of weight, etc. (with the exception just mentioned), or if definite and prolonged painfulness and inflammation occur at the site of injection—the skin reaction. If the rise of temperature and the other symptoms last but a few hours, the dose may be reduced a half; if they last all day the next dose should be one-tenth, or less, of the preceding dose. When the reaction has been marked or has lasted several days in spite of rest, the next dose should be one hundredth to one thousandth of the last dose. A dose that produces no effect of any kind should be increased, even in febrile cases, until signs of a favorable or unfavorable reaction appear. The dose should also be increased when the hitherto appropriate dose is losing its effect, as shown by a rise to a higher level of a temperature that has been kept down, or the reappearance of more marked daily fluctuations, and an increase of symptoms which had previously been ameliorated. A safe rate of increase in ordinary cases is about 50 per cent. of the preceding dose, or, according to the following scheme: 1, 1.5, 2, 3, 5, 7, 10, 15, 20, 30, etc. The intervals between doses may be three to seven days in patients who have shown no effect of any kind from tuberculin and in those who are doing well on it. In advanced cases and in nervous and susceptible individuals, and with the larger doses, ten days would often be better. After an unfavorable reaction one must wait until all the reactive symptoms have disappeared, a week or more after, if the reaction has been severe.

Every uncomplicated case of pul-

monary tuberculosis of the first and second stages with no or slight elevation of temperature is usually suitable for tuberculin treatment. In the writer's experience latent cases as a rule were not benefited by tuberculin.

Iodine.—Despite the skepticism of many authorities iodine has stood the test of time in the treatment of tuberculosis and has plenty of testimony of experienced and trustworthy clinicians and some laboratory evidence as to its efficacy in this disease, especially in the early stages. In fact, it is regarded by many as a specific, producing a vital reaction and immunization.

Iodine may be given by mouth or by inunction or intravenously. The best preparation by mouth is **iodoform** free from biproducts or impurities, such as the **eka-iodoform** of Schering. It may be given in doses of $\frac{1}{8}$ grain (0.008 Gm.) three times daily, increased gradually to the point of tolerance. **Tincture of iodine**, **compound tincture of iodine** and **Lugol's solution**, given in drop doses in a glass of water before meals, increased gradually to the point of tolerance, has a local action in quieting vomiting and increasing the appetite in addition to its general effect. A host of proprietary preparations of iodine may possess more or less or equal value.

By inunction iodine is given in the form of **euophen** or **iodoform** in oil or iodized oil. An excellent formula of Flick's is **euophen**, $\mathfrak{z}\text{ij}$ (8 Gm.); **Ol. gaultheria**, $\mathfrak{f}\mathfrak{z}\text{ij}$ (8 c.c.); **Ol. olivæ**, q. s. ad $\mathfrak{f}\mathfrak{z}\text{ij}$ (30 c.c.).

Intravenously 10 minims (0.6 c.c.) of a 40 per cent. ethereal solution of liquid paraffin which contains $\frac{1}{2}$ grain

(0.03 Gm.) of iodoform may be injected every second or third day.

Creosote and its Derivatives.—Another agent that has stood the test of time, despite the skepticism expended by many authorities, is the creosote group. They are especially applicable when destructive changes have begun and also when the toxemia and increased destruction of the third stage are manifest.

In this group are creosote, guaiacol, and their carbonates. The preparation of preference is **creosote carbonate**, which may be given in doses of 5 drops gradually increased to the point of tolerance and is best administered well beaten or shaken up in hot milk. In giving creosote the pure beechwood creosote is used, beginning with $\frac{1}{2}$ or 1 minim (0.03 or 0.06 c.c.) and increasing to the point of tolerance. It may be given in large draughts of hot water or in milk, wine or one of the malt preparations, always after meals. It may also be given in capsules with an oily vehicle. **Guaiacol carbonate** can be given in capsules in doses of 3 to $7\frac{1}{2}$ grains (0.2 to 0.45 Gm.) three times a day, increased slowly to 15 or 20 grains (1 to 1.3 Gm.). Ten to 25 minims (0.6 to 1.5 c.c.) of guaiacol have been painted on the skin to reduce temperature.

Arsenic and its Compounds.—Arsenic may be given by mouth in the form of **arsenious trioxide**, **arsenious iodide** and **Fowler's solution**, or hypodermically in the form of **sodium cacodylate**, $\frac{1}{2}$ to 1 c.c. (8 to 16 minims) of a 10 per cent. aqueous solution being injected two or three times a week.

Calcium.—In giving calcium we aid nature by increasing her supply of a

chemical used by her in combating tuberculous infection and healing tuberculous disease.

The preparations most used are **calcium chloride**, **calcium lactate**, **calcium lactophosphate**, and the average dose is 5 to 15 grains (0.3 to 1 Gm.) three times daily to every three hours.

It is essential to give calcium throughout the whole of pregnancy and lactation when there is an extra strain on the body's supply. Given during the menstrual period, when calcium is excreted in large quantities in the lochia, it may avert the hemoptysis which is so common at this period. In hemorrhage its employment is general, on account of its action in increasing the coagulability of the blood; but for this it must be given in large doses, 15 to 20 grains (1 to 1.3 Gm.) every three hours.

Thyroid gland in doses of 1 to 3 grains (0.065 to 0.2 Gm.), increased gradually, if desired, to tolerance or to 5 grains (0.3 Gm.) three times daily, is given to increase the general nutrition and activate the defensive process more vigorously. It should be borne in mind, however, that American preparations contain 5 grains of the gland to 1 grain of the desiccated gland on the market. Sajous, who introduced its use, warns against its employment in the advanced stages of the disease.

Nuclein is given to produce leucocytosis and increase the opsonic index. It may be given by mouth in the form of 1 dram (4 Gm.) of a 5 per cent. solution of **nucleinic acid** three times daily, or of 50 to 150 grains (3.2 to 10 Gm.) of **dried yeast** in milk twice a day, or of an ounce (30 c.c.) of **brewers' yeast** twice or three times

a day. Nucleinic acid may also be given subcutaneously and intravenously.

Cinnamic acid and its sodium salt **hetal** are also given to produce leucocytosis, and the latter also for its action in increasing connective tissue about the tuberculous focus. They are given by mouth, inhalation, subcutaneous injection, but preferably by intravenous or intramuscular injection.

Mercury.—B. L. Wright employs daily deep muscular injections of **mercuric succinimide**, beginning with $\frac{1}{15}$ grain (0.004 Gm.), slowly increasing the dose to the point of tolerance. He gives a course of 30 injections, followed by two weeks' interval of rest, and then by another course of 30 injections, and so on, for a year; after which a rest of from 2 to 3 months is given, whereupon, if the patient is not cured, treatment is resumed. Stuart, Shattuck, Bowditch, Edelheit, and Giampetro had previously given mercury in tuberculosis.

Strychnine.—According to Pepper and others, the dose of strychnine, which is at first a small one, is consequently gradually increased until the physiological effects of the drug are noted. S. Solis-Cohen says that the large doses should be given only for limited periods and that the use of strychnine should not be continued indefinitely, as this tends to exhaust nervous structure and nervous energy. Most physicians, at the present day, merely employ strychnine in ordinary dosage as a tonic or general stimulant, for its favorable action upon lowered blood tension, weakened heart, jaded appetite, and neurasthenia.

Ichthyol has been extensively employed in tuberculosis. It may be given in capsule or in a liberal quantity of water followed by lime-juice, lemonade or coffee. The dose is 2 drops, gradually increased.

Camphor is given subcutaneously in daily doses of $\frac{1}{4}$ to $1\frac{1}{2}$ grains (0.03 to 0.1 Gm.) in a 10 per cent. solution of olive oil. It is usually given as a heart stimulant, having a favorable, but not constant, effect on the heart, pulse and respiration, but is also said to have a favorable influence upon fever, sweating, expectoration and sleep.

Digitalis in small doses is given by Jacobi to prevent the cardiac enfeeblement, circulatory weakness, and general debility, due to a chronic ailment with the addition of obstruction in the lungs. Beddoes gave digitalis in large doses as a result of his empiric observation in cases of *galloping consumption*, with high fever and rapid pulse, and reports striking instances of the benefit following its use, his observation having been empirically confirmed by S. Solis-Cohen, who says it must be given continuously and fearlessly, up to the point of tolerance, the only contraindication being evidences of untoward effect on the stomach.

Nitroglycerin is considered useful in the early stages by S. Solis-Cohen, and is used in hemorrhage by many.

Quinine in large doses was administered by Jaccoud in the fever of different stages of phthisis, not less than 16 grains (1.04 Gm.) of **quinine sulphate** or 22 grains (1.4 Gm.) of **quinine hydrobromate** being given in twenty-four hours. The writer has obtained excellent results in many cases of tuberculous toxemia, with

reduction of the high septic fever and amelioration of the other toxic symptoms, by the exhibition by mouth of the **quinine bichloride** and **urea**, given in doses of 5 to 10 grains (0.3 to 0.6 Gm.) every three hours to once a day, administered in capsules. While the results may be due to the quinine alone, there is a possibility that some of the good effects may be due to the urea.

Urea in doses of 10 to 15 grains (0.6 to 1 Gm.) three times daily increased to 50 grains (3.2 Gm.) three times daily, has been used by Dixon, Harper, Buch and others with good results, which still others have failed to obtain.

Iron is indicated in the secondary anemia of tuberculosis. The best results seem to follow the daily hypodermic use of 0.05 Gm. ($\frac{5}{16}$ grain) of the **citrate of iron** obtained from Italian pharmaceutical houses or 0.03 Gm. ($\frac{1}{2}$ grain) of the **cacodylate of iron**. **Blaud's pills**, **syrup of the iodide of iron**, and **tincture of the chloride of iron** are also useful preparations.

Other drugs which are regarded of value in the treatment of pulmonary tuberculosis include **sodium salicylate**, **salicylic acid**, **sodium benzoate**, **benzoic acid**, **hypophosphites**, **glycerophosphites**, **palladium chloride**, **allyl sulphide**, **codliver oil**, **balsam of Peru**, **silver**, and **lecithin**.

SURGICAL TREATMENT.—**Artificial Pneumothorax.**—Air is introduced into the pleural cavity to produce collapse of the lung, the compression and immobilization tending to stop the growth of tuberculous foci, to cause healing by cicatricial contraction, to diminish the amount of toxic absorption, and to lessen the

amount of secretion and its aspiration into other healthy parts.

The simpler method of procedure and the one usually employed is to introduce without anesthesia, under aseptic conditions, through an intercostal space, a small aspirating needle connected with a suitable apparatus, entrance into the pleural cavity being ascertained by the reading of an attached monometer. When free pleural space is encountered, from 500 to 1000 c.c. of nitrogen gas, or atmospheric air passed through sterile cotton filters is introduced. The inflation is repeated every two or three days until the lung is completely collapsed, as indicated by Röntgen examination: then once a week, and later, when the pleura loses its capacity for absorption, at intervals of from two to three weeks.

Benefit, apparently lasting, and palliation occur in many cases, but on the other hand in a number of cases difficulties, accidents, and distinct harm have resulted. In the presence of extensive adhesions it may be impossible to find the pleural space. Pleural effusion is a common occurrence, frequently being met with in 33 to 100 per cent. of an operator's cases. Other complications are pyopneumothorax, air-embolism, pleural reflex causing death, inability of the lung to re-expand, with permanent loss of the functional capacity of the lung, and the formation of adhesions preventing subsequent inflation. Consequently, conservatism is desirable in the selection of cases. A conservative attitude is that in early or even moderately advanced cases the patients should be given the benefit of a try at the ordinary hygienic-dietetic treatment. If they do not improve,

then one should not delay too long in inducing pneumothorax. Extensive adhesions on the side in question, considerable destructive disease on the other side, severe cardiac disease, and severe complications in other organs, which do not include laryngeal disease, or non-tubercular diarrhea, are strict contraindications.

Chondrotomy of the first rib cartilage is designed to bring about a widening and mobilization of the upper thoracic aperture, but has not met with general approval.

Extra-pleural thoracoplasty aims to put the chest-wall into such a condition that the diseased lung becomes collapsed and motionless, for which rib resection, with more or less removal of bone, is necessary. It also lacks favor.

Inhalations.—Continuous or intermittent antiseptic or medicinal inhalations have been advocated, the patient wearing a zinc inhaler carrying a sponge and fitting like a cage over the mouth and nose and being kept in place by elastic bands around the ears. Various medicaments have been used, the most valuable being equal parts of **creosote**, **alcohol**, and **spirits of chloroform**; one-fourth each of **carbolic acid**, **creosote** and **spirits of chloroform** and one-eighth each of **tincture of iodine** and **spirits of ether**; and **ethyl iodide**. Other substances used singly or variously combined are **myrtle**, **eucalyptol**, **thymol**, **menthol**, **oil of peppermint**, **camphor**, **bromoform**, and **formaldehyde**.

TREATMENT OF SYMPTOMS.

—**Fever** is combated by absolute rest in bed, out of doors if possible, **tepid sponging**, **ice-cap** if grateful, **creosote carbonate**, the **bichloride of quinine** and **urea**, **tuberculin** when the fever is

moderate, and by treating any causal intercurrent affection.

Night-sweats are usually relieved by ordinary hygienic measures, but may require in addition frequent **nourishment at night when awake**, **sponging at bed-time with vinegar and water**, **pure vinegar**, **cool water**, or **formalin in alcohol**, the application of the cold stimulating **chest compress** all night, or of an **ice-bag** to the **abdomen** for several hours in the evening, and **atropine**, **picrotoxin**, **agaricin**, **aromatic sulphuric acid**, or **camphoric acid** by mouth.

Cough, when in excess of psychological needs, can often be controlled by **mental discipline**, **sips of cold water**, or **alkaline water**, **bits of ice**, **orange-juice**, **lozenges**, **candy drops**, the stimulating **chest binder**, **inhalations**. Sometimes sedatives may be required, such as **cherry-laurel water**, **syrup of wild cherry**, **hydrocyanic acid**, **chloroform**, **chloral** and **bromides** and even opiates such as **codeine**, **heroine** and **dionin**.

Hemoptysis demands calming, rest in a **semi-recumbent position**, withdrawal of food and fluids and substituting meat-juice with ice, pieces of ice in mouth occasionally, an **ice-bag over the heart**, forbidding of moving or talking, **nitroglycerin**, **morphine**, **calcium** in large doses, **thyroid gland**, the injection of **horse serum** or of **citrated human blood**, emptying the bowels, and in severe cases **bandaging the limbs** and, where the site of the hemorrhage is known with certainty, the induction of **artificial pneumothorax**.

PROPHYLAXIS.—Prophylaxis is general and individual. Individual prophylaxis consists in precautions taken by the patient to avoid infect-

ing. Inasmuch as the spray from a cough may contain the bacilli, when a patient coughs he should hold in front of his mouth a Japanese napkin or a cloth which is then put in a paper bag to be subsequently burned. He should expectorate into such a paper napkin or cloth or into a paper sputum cup which is burned or into an indestructible sputum cup, pocket flask or spittoon containing a disinfectant. The patient should have his own eating utensils, which are kept and washed separately. He should avoid hand-shaking and kissing.

Well persons, especially those susceptible or of tuberculous families, should pay strict attention to personal hygiene—by which is meant proper air, proper food, proper bathing, proper exercise and rest, and avoidance of excesses of all kinds. By building up one's resistive power and increasing the protective substances of the body, one renders less likely the occurrence of tuberculous diseases following a chance tuberculous infection.

Probably the most important general prophylactic measure is the education of the public; one of the great causes of consumption being the ignorance of the general public as to the nature and extent of the disease, and as to its prevention and treatment. Campaigns of education should consequently be carried on by public health officials and anti-tuberculosis societies and insurance companies, including the preparation and distribution of suitable literature in the form of leaflets, pamphlets, and books adapted for the public as a whole and for special classes or groups, and published in different languages; the utilization of posters or bill-boards

and of maxims printed on the backs of street-car transfers; the distribution in tenements and homes of art posters with advice on them, the use of the columns of the newspapers and the pulpit, the holding of exhibits, the giving in various languages of popular lectures, and of special talks to special groups, the employment of the phonograph and moving picture and use of seals and stamps.

The administrative control of tuberculosis with compulsory notification enables the health authorities to protect the public from tuberculosis as they do from other communicable disease through the exercise of a sufficiently strict surveillance over tuberculous individuals so as to make them take adequate precautions to render themselves free of danger to other persons, and through the fumigation of rooms that have been occupied by consumptives. Of equal importance is the increasing of resistance to tuberculosis by demanding hygienic conditions in house, tenement, factory, store, and workshop, with reference to lighting, heating, ventilation, plumbing, cleanliness, overcrowding and air space; the proper arrangement of a city with regard to the relative width of the streets and the height of the buildings, the laying out of small parks, open spaces, and children's playgrounds; attention to the purity and character of the food supplies, especially the milk supply, the supervision of slaughter houses, the regulation of the hours and conditions of labor; attention to school hygiene and the establishment of open-air schools and classes; the proper sweeping of streets and disposal of refuse, destruction of the fly, suppression of indiscriminate expect-

toration and provision for the disposal of sputum, and the maintenance of sanitary precautions in railroad and railway cars, especially sleeping cars. For the proper care of tuberculous patients it is incumbent on the health or other authorities to provide dispensaries, sanatoria, day camps, night camps, classes, home hospitals, preventoria, farm colonies, nurses and proper accommodation in insane asylums, prisons, reformatories, almshouses and boarding schools.

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Philadelphia.

TUBERCULOSIS OF THE SEROUS MEMBRANES AND SKIN.

Several disorders of the serous membrane, i.e., tuberculosis of the pleura, pericardium, peritoneum, etc., have already been reviewed in the articles on the diseases of these various organs. There remain for consideration tuberculosis of mesentery and endocardium, the latter of which is encountered with comparative rarity.

Mesenteric Tuberculosis or Tabes Mesenterica.—This disease is characterized by a tuberculous infection of the lymphatic nodes of the mesentery, and is observed mainly in young children who have been fed on milk derived from tuberculous cows; or it may be secondary to a tuberculosis elsewhere in the body. In older children and adults it may be due to the inhalation and swallowing of bacilli-laden dust or foods. Both bovine and human tubercle bacilli may cause the disease, the bovine type being causative in 60 per cent. of all cases.

Tuberculosis of the mesenteric glands in children is a very common condition, being found in practically every child submitted to an abdominal operation. This is due to the fact that the food stagnates in the ileocecal region while it undergoes absorption of a large part of its water. This pause is made in a warm, slightly alkaline medium and the contained micro-organisms mul-

tiply very rapidly. This is shown by cultures from here and from other portions of the intestinal tract. Corner (Lancet, Feb. 17, 1912).

SYMPTOMS.—There are two distinct clinical types of the disease. The first or *acute type* may begin suddenly with more or less sharp, colicky pain, nausea, vomiting, and marked tenderness on the right side somewhere between the umbilicus and the cecum with more or less fever. The attack is usually taken for one of acute appendicitis. On opening the abdomen the appendix is found normal, but one or more caseating enlarged glands are found on the mesentery, often to the right and opposite the second or third lumbar vertebra. If removed, even though the glands be found laden with tubercle bacilli, recovery usually results.

In the second or *chronic type*, with gradual development, the mesenteric glands are more or less destroyed functionally; there is gradual emaciation, therefore, even though an effort at compensation be made by the patient through excessive appetite. The unassimilated food putrefying in the intestinal canal causes diarrhea with excessively fetid stools. Pallor of the skin and mucous membranes, slight fever of an intermittent type, and weakness become increasingly pronounced. There is more or less severe colic, the abdomen being also painful when compressed and sometimes swollen. This, however, is often due to a peritoneal effusion. A moderately hard fluctuating or doughy mass may usually be felt in the abdomen, particularly in children. The von Pirquet reaction is useful to establish the diagnosis on a solid footing.

Many young subjects harbor tuberculous glands that do not give rise to appreciable symptoms, but they may become the starting point of a general infection. On the other hand if recovery occurs the possibility that the inflammatory adhesions formed may compromise the functional integrity of the intestine is to be borne in mind. The chronic form progresses steadily toward a fatal issue if left untreated.

DIAGNOSIS.—Primary tabes mesenterica affords a sufficiently clear history and syndrome to warrant its recognition

if the enlarged glands are palpable. Obscure abdominal pain with persistent digestive disturbances and steadily progressive emaciation suggest its presence. In children and adolescents a pain in the right abdominal area between the umbilicus and the cecum or below the umbilicus, especially when there are palpable masses, is suggestive of *tabes mesenterica*. There may be pain on both sides, and the feces may contain mucus, blood-streaks and tubercle bacilli even where there is no diarrhea. A skiagraph is helpful in locating the enlarged glands.

PROGNOSIS.—As compared with the prognoses of other tuberculous diseases *tabes mesenterica* is probably that which offers the best chances of recovery. If discovered early much may be done by medical measures. The prognosis is also good under operation provided it is performed when the glands form a palpable mass. In the acute form an exploratory incision, even without removing the tuberculous gland, may prove curative. Under all conditions, however, the prognosis should be guarded, owing to the frequency of unexpected complications.

TREATMENT.—The medical treatment is the same as that recommended for tuberculosis of the peritoneum (see seventh volume, page 391). Of special value, however, is **creosote carbonate** 5 to 10 drops three times a day. **Warm compresses** and **mercurial ointment** inunctions over the abdomen are also recommended.

As to surgical procedures they are indicated when the medical measures fail to cause improvement. **Laparotomy** is beneficial even without removing the diseased glands, and, as stated by Corner some years ago, experience has shown that **resection of the glands** should be done only when they form a palpable mass, care being taken to distinguish them from tumors due to tuberculous peritonitis. A child with movable tumor of the abdomen, not fecal, who is losing flesh and wasting, should undergo operation.

TUBERCULOSIS OF THE MYOCARDIUM.

This condition usually occurs as a complication of miliary tuberculosis and

tuberculous pericarditis. The tubercles or miliary nodules tend to follow the course of the vessels. The only signs by which its presence may be surmised is a more or less sudden weakness of the cardiac contractions, a true cardiac myasthenia.

TREATMENT.—Besides the measures addressed to the general causative disorder, **digitalis** is indicated to sustain the cardiac action, and promote nutrition of the musculature. Besides, **rest**, though in the open air, becomes imperatively necessary to decrease the danger of cardiac arrest.

TUBERCULOSIS OF THE SKIN.

Tuberculosis of the skin may be divided into seven main forms: *scrofuloderma*, *true tuberculosis*, *miliary tuberculosis* (or *Milium*, previously considered in the sixth volume), *tuberculosis verruca cutis*, *lupus vulgaris*, and *lupus erythematosus*.

SCROFULODERMA.—The term "scrofula" being equivalent, in the light of modern teachings, to tuberculosis, this disorder is now regarded as a tuberculous disorder of the skin due to infection and ulceration of the underlying lymphatic glands.

Symptoms.—Scrofuloderma begins in one or more lymph-nodes, in most instances in those of the neck, but also those of the face, lids, bones, and other regions. The infected glands swell, involve the overlying skin, the latter gradually becoming violaceous or livid owing to the pressure upon its vessels and defective nutrition. The gland then breaks down, the skin likewise, and a sanious pus is discharged. The ulcers formed have ragged edges and multiply along the chain of lymph-nodes, forming linear ulcerations while fistulas undermine the cutaneous tissues. The ulcers are practically painless and if cicatrization occurs the scars are irregular, knotty, and depressed, having an ugly, permanent reminder, especially where the neck is affected, of the so-called "scrofulous" taint.

Etiology and Pathogenesis.—The patients are practically always young, have unusually transparent though doughy and anemic skins, thick lips, especially the upper, and are flabby, dull, prone to

lymphatic enlargements, adenoids, tonsillitis, catarrhal disorders of various kinds, and are a ready prey for infectious diseases, particularly those due to the tubercle bacillus. Although the tubercle bacillus cannot always be found in the swollen glands, inoculation of the pus in guinea-pigs usually give rise to typical tuberculous swellings.

Treatment.—This should include measures addressed to the body at large, since the actual extent of the infection in a given case is never known. **Nutritious food**, especially milk and eggs, **pure air**, **sunlight**, **sea-air**, the **iodides** and **hypophosphites**, **guaiacol**, and **creosote carbonate** are the standard measures indicated. **Mercury succinimide**, $\frac{1}{8}$ grain (0.073 Gm.) subcutaneously, has also been used.

A striking effect on cutaneous tuberculids is produced by **arsphenamine**. Fifty-three per cent. of 17 cases were completely cleared of lesions, and only 12 per cent. failed to show betterment. **Outdoor life**, **forced diet**, **correction of vascular abnormalities** and **stasis** by **elastic support**, and **removal of secondary pyogenic foci** in tonsils, teeth, etc., are important adjuvants. Stokes (Amer. Jour. Med. Sci., Apr., 1919).

Radium used in the various forms of skin tuberculosis, including lupus vulgaris, with good results. Aikins (Urologic and Cutaneous Review, Jan., 1918).

Tuberculin does not seem to prove effective in the average case, but in very small doses it sometimes acts beneficially in children in the presence of a positive von Pirquet reaction. **X-rays** and **heliotherapy** have also given good results in some cases. The local and surgical measures have already been treated in full in the article on TUBERCULOUS ADENITIS, in the first volume, page 356, to which the reader is referred.

TRUE TUBERCULOSIS OR TUBERCULOSIS CUTIS.—This rare disease is due to contact with tuberculous ulceration. It is characterized by small tubercular growths usually found on the lips, the vulva, or anus, which gradually soften and become the foci of ulcerations.

These are usually covered with sanious purulent discharge, retained *in situ* by the clear-cut edges of the ulcers. When this discharge is removed, the bottom of the ulcer is found to be red; if left in place it becomes transformed into a grayish crust.

Treatment.—The treatment is the same as that for scrofuloderma. But reinfection constantly recurring, cure is dependent upon that of the general infection.

TUBERCULOSIS VERRUCA CUTIS, also known as **verruca necrogenica**, **post-mortem warts**, etc., is the result of a tuberculous infection of the skin in the course of autopsies, or any other form of contact with infected tissues.

Symptoms.—This rare disease starts as a nodule, which eventually resolves itself into a patch ranging in size from that of a millet-seed to that of a half-dollar. Each patch is surrounded by two zones, one red or violaceous, the other brownish red. The outer zone contains a row of small pustules, but the inner is the seat of wart-like growths. These are more or less scaly and produce pus when squeezed from side to side. The patch ultimately flattens and becomes converted into a smooth and thin, scarified patches are added to the original ones by confluence and thus spread, though very slowly, the disease being essentially chronic. The spreading patches cause no pain unless pressed upon. The lesions are in most instances on the hands, the knuckles in particular, the region most exposed to infection in the occupations which expose to contact with infected animals and their carcasses, the disease being mainly observed in veterinary surgeons, butchers, dead-house attendants, hostlers, drovers, etc. Unlike lupus it tends to heal in the center by scar formation, while new ulcers are being formed.

Treatment.—The treatment of this condition is similar to that for lupus vulgaris, i.e., thorough destruction of the ulcers by one of the various forms of **cauterization** or, in the milder cases, by the use of **pyrogallol**. All these measures are given in **treatment** under the next heading.

LUPUS VULGARIS.—This is a tuberculous lesion of the skin or mucous membrane, characterized by brownish-red

patches, which may proceed to ulceration and invade adjoining tissues.

Symptoms.—Lupus begins in the form of yellowish-red or copper-colored projections or nodules varying in size, from that of a millet-seed to that of a split pea. They may become aggregated into patches which, by coalescing, in turn cover extensive surfaces; but, as a rule, they do not; they are indolent, soft, and elastic, and sometimes slightly sensitive to pressure. When the seat of several blood-vessels, they assume the form known as the *myxomatous lupus*, and, when exceedingly vascular, the *angioma-tous lupus*. Their progress is exceedingly slow.

In *lupus excedens* the cutaneous tubercles break down and ulcerate, and become covered with scabs, overlying a bed of sanious pus; under this the ulceration gradually extends, eating its way in all directions. The neighboring tissues are slightly tumefied, and a narrow, reddish areola is usually present. After a certain time, the ulceration involves the deeper structures, and all tissues—muscular, cartilaginous, tendinous, etc.—are gradually invaded. The mucous membrane of the nose, mouth, pharynx, larynx, and the conjunctiva are often gradually included in the destructive process, and deformities of the nose, mouth, lids, etc., result. Unfortunately, this terrible disease shows a distinct predilection for the face, though it may also develop in the skin of the limbs, buttocks, and trunk. Again, the ulcerative form almost invariably attacks the nostrils, internally or externally, destruction of this organ being but a matter of time unless the disease is mastered.

In the *lupus exfoliatus* the tubercles remain practically stationary, then flatten out, and leave in their stead a wrinkled surface, which becomes exfoliated, and ultimately disappears, leaving in its stead a small scar.

When the destructive process advances with great rapidity, destroying everything in its wake, it is termed *lupus vorax*; when the suppuration is slight and the lesion is hard, verrucous, or papillomatous, it is termed *lupus verrucosus*, or *papillomatosus*; when the affected tissues

are greatly thickened and deformed, it is termed *lupus hypertrophicus*, etc.

All the forms of lupus, with the exception of *lupus vorax*, progress slowly. It may, after a period of slow development, become stationary and even recede until complete recovery is attained. This is rarely observed, however. A peculiarity of the disease is its tendency to become complicated with other cutaneous disorders: erysipelas, adenitis, epitheliomatous cancer, etc.

Diagnosis.—Lupus vulgaris may be confounded with tertiary syphilis, epithelioma, rodent cancer, and scrofuloderma. The syphilitic eruption most likely to be mistaken for lupus is a subcutaneous gumma, which after a time ulcerates and becomes covered with a scab; this heals and others form just beyond, advancing in a serpiginous manner. A scar is formed which resembles lupus, except that there is pigmentation around the patch, and the cicatrix is thinner, softer, and less fixed than lupus.

Epithelioma is more painful, progresses more rapidly, and is liable to hemorrhages; lymphatic glands in the neighborhood and the deeper structures are invaded. The edges of the ulcer, too, are raised and hard. *Rodent cancer* arises late in life, the edges of the ulcer contain no nodules, and there are no granulations on the ulcer. It is always single, and does not cicatrize spontaneously.

Etiology and Pathology.—The majority of patients show a decided tendency to tuberculosis in their family history, or are tuberculous themselves. Hence the predilection of some families to lupus. This includes the cases in which contamination of the skin occurs through the lymphatics from tuberculous foci elsewhere in the body. It is essentially a disease of the young. It may begin as early as the second year and is more frequent in males than females.

The lesion consists of a small cell-infiltration deep in the corium at first and which thence penetrates all cutaneous structures. The tubercle bacillus is found therein, but not in large numbers.

Prognosis.—Although recent labors have improved the chances of recovery, the disease remains a difficult one to over-

come, and sometimes seems to baffle all efforts. Again, it may apparently yield to appropriate treatment and suddenly reappear—all features which should suggest reserve.

Treatment.—An important feature of the treatment of lupus vulgaris is attention to the general health. It is a tuberculous affection and, therefore, due to inadequate defensive efficiency. **Out-of-door exercise, wholesome food, tonics, etc.,** tend greatly to assist the local measures by increasing the powers of resistance of the tissues to bacillary invasion.

Radical measures are necessary to eliminate every cell of the diseased area. This may be done in various ways: **curetting** with dermal curette, **cauterization** with galvanocautery, at cherry heat, or the Paquelin cautery, multiple **scarifications** with the scarifying knife, or destruction of the individual tubercles by **boring** followed by **phenic acid** applications. **Electrolysis**, the needles being passed through the patch, has also been advised.

Excision is the most radical of measures, but the cosmetic results are often such as to require considerable plastic work, unless the lesion be relatively small. A graft must then be inserted fitting exactly the area excised. Thiersch grafts sometimes give good results. **Subdermal separation** of the diseased area may also be resorted to. It is done by inclosing the area between two parallel incisions down to the muscle and detaching the skin from the latter so as to form a bridge flap; underneath the latter is then drawn iodoform gauze dipped in Peruvian balsam to prevent union of the separated surfaces. This "undermining" treatment (Payr) causes the skin to recover its normal condition, leaving no defect. Local anesthesia suffices for all these procedures unless the lesion be extensive. It should be remembered, however, that all cutting operations involve the danger of causing general infection when the cutaneous lesion is a primary one, and that the operative asepsis should be rigid.

Among the milder though none the less effective agents used are **pyrogallol acid**, a 10 per cent. **petrolatum salve** being

kept *in situ* several days, then replaced by a weaker salve as the ulceration heals. Strong salves of pyrogallol are painful. **Lactic acid** is an efficient and comparatively painless caustic. The crust having been, if possible, removed, the parts are sprayed with a 4 per cent. solution of cocaine, and the edges, after three or four minutes, are carefully moistened with the acid, using a small cotton pledget or a wooden tooth-pick for the purpose.

A saturated solution of **trichloroacetic acid**, prepared by adding 10 drops of distilled water to 1 ounce (31 Gm.) of pure crystals, is also active, used in the same way. The two last-named acids exert a selective action on the tuberculous nodules. The applications are followed by the formation of crusts which exfoliate in from five to ten days. The areas touched every two weeks should not be larger than one inch in diameter. **Phenic acid** may be painted on the diseased area from two to four days in succession. Or Unna's salve muslin composed of **phenic acid** 20 parts, **mercuric bichloride** 1 part, and **oxide of zinc** 36 parts may be used.

Solid carbon dioxide whittled to a tip, a disk, etc., can be used to destroy the lesions by keeping it in contact with them about one minute. It is practically painless owing to the intense cold developed which acts as anesthetic. The slight subsequent burning may be controlled by **cold compresses** or a weak solution of **cocaine**.

White recommends Boeck's paste composed of **pyrogallol acid**, **resorcin**, and **salicylic acid**, of each 7 parts; **gelatin** and **talc**, of each 5 parts. This is applied to the diseased tissue with a wooden spatula and covered with a thin layer of absorbent cotton. Within 24 to 48 hours, chocolate-colored pus begins to run from the lower level of the dressing and continues to do so, but in diminishing amounts. At the end of a week the application is removed by the aid of diachylon ointment, and a clean, granulating surface is disclosed, dotted with numerous islands of healthy, active epithelium. Dewar obtained recovery with the following: After washing off the scabs with hot water, the lesions are dried, and thin pieces of cotton-wool, soaked in a 5 per cent. solution

of cocaine, are applied to the ulcers for a few minutes. On removing these, thin films of cotton-wool, soaked in a 10-volume solution of **peroxide of hydrogen**, are left on and kept in position by touching the edges with collodion. Every second day the patient is given an intravenous injection of 15 minims (0.9 c.c.) of an ethereal solution of **iodoform** plus liquid paraffin.

Tuberculin has not on the whole proven satisfactory, though a few instances of recovery have been reported. Yet the presence of foci elsewhere warrant its use along with measures addressed to general tuberculosis. Valuable in this connection is Pfannenstiel's method—30 grains (2 Gm.) of **sodium iodide** per day in divided doses, while the lesion is kept constantly moist with a 10-volume solution of **hydrogen peroxide**. Free iodine is liberated in the lesions.

The **Finsen light** treatment or **phototherapy** is very efficient, though slow. Of 1200 cases treated at the Finsen Institute, Copenhagen, 60 per cent. were cured.

Artificial heliotherapy with the **carbon arc light** found valuable in lupus. The entire body was exposed to the rays for one-quarter to two and a half hours, every second day. The course lasted from four to eight months. Reyn and Ernst (*Hospital-std.*, May 16, 1917).

Lupus near facial orifices requires crossed linear **scarifications**. The nasal fossæ must be carefully treated by scarifications or **scraping**, followed by **cauterization**. After scarification, **potassium permanganate** or **zinc chloride** should be applied, and finally **mercurial plaster**. Lupus of very small extent on the face, limbs, or trunk should be **excised**. Moderate-sized lupus is susceptible to **heliotherapy** or repeated **scraping**, followed by **cauterization** and **iodoform** dressings. In ulcerated lupus, **mercurial plasters** or **potassium permanganate** should first be tried. Rapidly spreading forms demand **scarification** at once; turgid forms, **calomel injections** or some form of **radiotherapy**. Brocq (*Jour. de méd. et de chir. prat.*, Feb. 25, 1919).

Exposure to **direct sun rays** five hours daily, where, as in Egypt, the sunshine is unclouded, has also given good results. The rest of the face is protected and the eyes shaded with a dark bandage. **Radium**, in heavy doses, acts more rapidly than the Finsen light, and may conveniently be used in cavities, the nose, mouth, etc. **X-rays** give the best results when the lesion is ulcerated and hypertrophic; this breaks down rapidly, but the smooth, dry lupus does better under the Finsen light and other measures. Where this is possible, however, the simultaneous use of **Finsen light** and **X-rays** gives far better results than either employed singly. Some hold that **Bier's hyperemia**, using suction cups, is more effective, and acts more rapidly than X-rays.

LUPUS ERYTHEMATOSUS.—This disease, also known as **lupus superficialis**, **seborrhœa congestiva**, **lupus sebaceus**, etc., is not believed to be tuberculous, as a rule, but the tubercle bacillus has been found in some cases with other indications of tuberculosis.

Symptoms.—The earliest appearance of lupus erythematosus is a patch of redness around the opening of a sebaceous gland. This gradually spreads, and the surface becomes scaly, the margin being defined, and slightly raised; the spots coalesce, and new ones form which, in their turn, join the older ones. The center of each patch may become covered by thick, shagreen-like scabs, which, when forcibly detached, bear on their under surface dried columns of epidermic cells which have been pulled out of the dilated openings of the sebaceous glands. The disease often becomes stationary after spreading to a considerable extent; the margins then lose their bright hue, and a depressed, punctate scar remains. When hairy parts have been affected, permanent baldness results from destruction of the hair-follicles. It occurs on the face oftener than elsewhere, and tends to be symmetrical. Starting on the nose or one cheek, it spreads in both directions, and in severe cases resembles a butterfly, the wings on the cheeks and the body on the nose. Other patches appear on the lobules of the ears and occasionally on the forehead, the backs of the hands, and the feet.

Several forms have been identified: (1) the *diffuse or disseminated*, which, though following the ordinary forms, progresses more or less rapidly, and resembles the papular stage of eczema or urticaria, and is rather rare; (2) the *telangiectatic*, characterized by thickening and redness of the skin due to dilatation of its vessels; (3) the *nodular*, in which raised, reddish nodules about the size of a lentil or small bean occur, usually about the face.

Etiology.—Lupus erythematosus seldom occurs after the thirtieth year or before puberty, about two-thirds of the cases being in females. It attacks people with feeble circulation such as are liable to chilblains, etc., and it chooses for its starting point a part where the blood-supply is poor and where there is little subcutaneous fat: *e.g.*, the nose, or ear. The eruption can sometimes be traced to exposure, to great heat, or to cold.

Many guesses are available concerning its actual pathogenesis, but none meets the various phases of the syndrome.

Treatment.—Many cases of lupus erythematosus can be cured, according to Unna, by the use of external applications. Among the external remedies which he has seen to do most good is the following prescription:—

R *Zinci oxidi*,
Boli rubræ 30 grs. (2 Gm.).
Boli albæ,
Magn. carbon. 45 grs. (3 Gm.).
Amyli 2½ drms. (10 Gm.).

M.

Another formula which, long continued, was found to be followed by a cure in a number of cases, without the help of any other remedy, is a combination of soap collodion, as in the following formula:—

R *Collodion* 5 drms. (20 Gm.).
Sap. virid. ½ to 1 dram (2 to 4 Gm.).

M.

The same clinician frequently employs medicated collodion painted over the affected area from 2 to 4 times a day. The collodion used for the preparation must have a neutral, not an acid, reaction:—

R *Saponis viridis* 2 to 4 parts.
Collodii flex. 20 parts.

M.

R *Saponis viridis*,
Ac. salicylici 2 parts.
Collodii flex. 20 parts.

M.

To be used if the skin shows much irritation:—

R *Ichthyolis* 5 parts.
Collodii flex. 20 parts.

M.

If the lesions are non-inflammatory, pale, and anemic, Kanoky paints them with a strong iodine preparation, repeated three times a week, and administering salicin internally. The latter may be alternated with quinine, or the latter substituted altogether. Where the induration is marked and the condition notably sluggish, agents possessing marked stimulating power are indicated. **Salicylic acid**, 40 parts, or **pyrogallie acid**, 10 parts, suspended in collodion, 100 parts, are applied at night with a camel's-hair pencil. If this causes too much irritation it should be temporarily discontinued and a soothing application substituted, such as:—

R *Zinci oxidi* 3ij (60 Gm.).
Olei olivæ 3x (40 Gm.).

M.

If the lesions are in the non-inflammatory, pale, and anemic state he advises painting them with a strong iodine preparation, repeating it three times each week. Hartigan, in cases with circumscribed lesions of the sebaceous and telangiectatic type, obtained the best results with a 2 per cent. solution of **zinc sulphate** or **copper sulphate**. MacLeod and others recommended **zinc ionization**. A 2 per cent. **zinc sulphate** solution is used, with a current of about 5 milliamperes, ten minutes at a time, to each patch. Nine sittings in all are given. Under this treatment the scalliness and redness disappear, leaving a pale, supple, slightly depressed scar.

Tuberculin often fails to benefit, and may prove dangerous and even fatal as in Ravogli's case. Nor are the X-rays nearly as effective as in true lupus, and may even prove harmful. The Finsen light has not given encouraging results. The liquid air treatment, however, is efficient, as shown by Fox, Dade, and others,

but the most satisfactory agent is the solid carbon dioxide. Gottheil states that while the intense cold prevents severe pain, light pressure for, say, 20 seconds, will give a moderate reaction without the ultimate formation of scar tissue, or with an amount of it so superficial as to be practically negligible. Harder pressure for 60 seconds or so will occasion marked reaction and destruction of the skin. And between these two extremes any desired amount of tissue destruction and scar formation can be gotten. C. E. DE M. S.

TURPENTINE (TEREBENE; TERPIN HYDRATE).

(crude, or white, turpentine; common frankincense; *terebinthina*, N. F.) is a concrete oleoresin obtained from *Pinus palustris* and other specimens of *Pinus* (nat. ord., *Conifera*). From this crude turpentine a volatile oil is distilled which is officially known as *oleum terebinthina* (U. S. P.), from which are prepared the official turpentine liniment and rectified oil of turpentine. Turpentine oil is a solvent for wax, iodine, sulphur, phosphorus, and the fixed oils.

When the oil of turpentine is distilled off from turpentine a resin (rosin) is left which is official (*resina*, U. S. P.) and from which are prepared the official resin cerate and plaster.

Canada balsam (*terebinthina canadensis*) is obtained from the balm-of-Gilead fir (*Abies balsamea*).

Other substances related to turpentine are terebene and terpin hydrate, also to be considered in this article.

PREPARATIONS AND DOSES.—

Terebinthina, N. F. (turpentine), occurring in yellowish, opaque, brittle, glossy masses, sticky internally and with a characteristic odor and taste. It is soluble in alcohol.

Terebinthina canadensis, U. S. P. VIII (Canada turpentine; Canada balsam; balsam of fir), the natural oleoresin of *Abies balsamea*, occurring as a viscid, pale-yellow, transparent liquid with an agreeable pine-like odor and a terebinthinate, slightly bitter taste. On exposure to the air it gradually dries to form a transparent varnish. It is soluble in ether, chloroform, benzol, xylol, turpentine, and oils.

Oleum terebinthina, U. S. P. (oil of turpentine), a volatile oil recently distilled from turpentine, occurring as a thin, colorless liquid with a characteristic odor and taste which become stronger with age and air exposure. It is soluble in 3 times its volume of alcohol.

Oleum terebinthina rectificatum, U. S. P. (rectified oil of turpentine), made by shaking oil of turpentine with an equal volume of the official solution of sodium hydroxide, recovering about three-fourths of the oil by distillation, and filtering. Its physical properties are the same as with the preceding, over which it is preferred for internal use. Dose, 5 to 30 minims (0.3 to 2 c.c.); average, 15 minims (1 c.c.).

Emulsum olei terebinthina, U. S. P. (emulsion of oil of turpentine), containing 15 per cent. by volume of rectified oil of turpentine, together with expressed oil of almond, acacia, and syrup. Dose, 1 fluidram (4 c.c.).

Resina, U. S. P. (rosin), occurring usually in angular, translucent, amber-colored, brittle fragments, with a faint odor and taste of turpentine, inflammable, easily fusible, and soluble in alcohol, ether, benzol, acetic acid, oils, and caustic alkalis. Dose 4 grains (0.25 Gm.).

Ceratum resina, U. S. P. (rosin cerate; basilicon ointment), made by melting together 7 parts of rosin, 3 parts of yellow wax, and 10 parts of lard.

Ceratum resina compositum, N. F. (compound rosin cerate; Deschler's salve), made by melting together 45 parts each of rosin and yellow wax, 60 parts of prepared suet, 23 parts of turpentine, and 27 parts of linseed oil.

Linimentum terebinthina, U. S. P. (turpentine liniment), made by dissolving 13 parts of melted resin cerate in 7 parts of oil of turpentine and mixing thoroughly.

Terebenum, U. S. P. (terebene), a liquid consisting of dipentene and other hydrocarbons, obtained by the action of concentrated sulphuric acid on oil of turpentine and subsequent rectification with steam. It occurs as a colorless, thin liquid with a thyme-like odor and an aromatic, terebinthinate taste, only slightly soluble in water, but soluble in 3 times its volume of alcohol. It gradually becomes resinified on exposure to light and air, and acquires

an acid reaction. Dose, 3 to 15 minims (0.2 to 1 c.c.); average, 8 minims (0.5 c.c.).

Terpini hydras, U. S. P. (terpin hydrate; dipentene glycol) [$C_{10}H_{18}(OH)_2 + H_2O$], the hydrate of the diatomic alcohol terpin, occurring in colorless, rhombic crystals, nearly odorless and having a slightly aromatic and bitter taste, permanent in the air, soluble in about 200 parts of cold and 32 parts of boiling water, in 10 parts of alcohol, in 100 parts of ether, and in 200 parts of chloroform. It melts and loses water when heated to 116° C. Dose, 2 to 10 grains (0.125 to 0.6 Gm.); official dose, 4 grains (0.25 Gm.).

PHYSIOLOGICAL ACTION.—Oil of turpentine, taken internally in moderate doses, gives rise to a sensation of warmth in the stomach. By "reflex" excitation the circulation may be quickened and the warmth of the skin increased.

According to Eustace Smith small doses, such as 5 or 10 minims (0.3 to 0.6 c.c.) have but little tendency to irritate the kidneys, while in doses of 2 to 4 drams (8 to 16 c.c.) or more the aperient action of the drug prevents its absorption in appreciable amount. Doses such as $\frac{1}{2}$ to 1 dram (2 to 4 c.c.), however, must be given with caution, tending to cause irritation of the genitourinary tract, with strangury and hematuria. The urine in which turpentine is being excreted acquires an odor of violets. Binet found that traces of turpentine appear in the expired air in a few hours after its ingestion.

The coagulability of the blood is apparently increased by turpentine. According to some researches conducted many years ago (1889) by Brémond and Hénocque it tends to increase bodily oxidation and improve nutrition.

Externally, turpentine causes reddening of the surface and sometimes vesication. It possesses marked antiseptic powers.

Terebene and terpin hydrate produce, so far as is known, general effects similar to those of turpentine. They are both credited with activity as stimulating expectorants, acting by local excitation of the bronchial mucosa as they are being in part eliminated through it. Terebene has a more pleasant odor than turpentine. Terpin hydrate has been held to be better borne by the stomach than terebene,

though perhaps slightly less active as expectorant.

UNTOWARD EFFECTS AND POISONING.—A scarlatinoid rash may follow ingestion of relatively large doses of oil of turpentine. In Blackwood's case such a rash followed the taking of 55 minims (3.5 c.c.) in twenty-four hours. Redness and mottling of the fauces may coexist (Angus). Ingestion of an ounce (30 c.c.) of oil of turpentine in Grupel's case caused marked chilliness, giddiness, and staggering gait, followed by painful urination, hematuria, thirst, anorexia, and headache, with recovery extending through three weeks. In some of the severe cases vomiting and purging, bloody stools, abdominal pain, suprapubic tenderness, and suppression of urine are noted. In the fatal cases, which are rare, marked circulatory weakness, coma, and respiratory failure follow. Joachim has reported such a case in a child of 3 years who drank a quantity of turpentine, death following in less than two hours. Poisoning can take place from inhalation. In Newman's case, that of a varnisher, the symptoms were persistent nausea, disturbance of speech, mental exhilaration, frontal headache, irritation about the gums, bladder irritability, constipation, dyspnea, and the usual odor of violets of the urine.

Treatment of Poisoning.—This consists in thorough evacuation of the stomach with emetics, if the case is seen early; purging with liberal doses of magnesium sulphate; giving milk, barley-water, or other demulcents; morphine hypodermically to relieve pain and severe cramps; hot flannels to the abdomen; a mixture of potassium citrate with belladonna or hyoscyamus to promote renal action and allay bladder spasm, and saline hypodermoclysis or infusion for eliminatory purposes and the relief of impaired circulation.

THERAPEUTICS.—Externally, turpentine is of value as a rubefacient, to induce counterirritation over deep-seated foci of inflammation. For this purpose a liniment of turpentine may be used or, to secure a more pronounced action, the "turpentine stupe" may be availed of by dipping pieces of flannel or of an old blanket in hot water, wringing them out, then dropping warmed oil of turpentine over them.

Or, 1 dram to 1 ounce (4 to 30 c.c.) of turpentine may be stirred in a quart of boiling water until emulsified, and the stupes wrung out of the resulting fluid. Again, 1 part of turpentine may be mixed with 7 parts of olive or cottonseed oil, applied to the part, and the area covered with a hot fomentation. Stupes are advantageously covered, in turn, with cotton or gauze followed by oiled paper or silk. When used to relieve intra-abdominal disturbances, as in tympanites and pain of moderate degree in **typhoid fever**, the stupes should not be allowed to grow cold on the skin, but changed every 10 or 15 minutes until the surface has been well reddened.

In **rheumatic joint or muscular affections**, including **lumbago**, an ointment or plaster containing turpentine may be used.

Turpentine acts rather powerfully as an antiseptic, and is recommended by Leven for rubbing into the skin once daily in **tinea versicolor** and for use in compresses, applied morning and evening, in **tinea tonsurans**. In **sloughing ulcers and gangrenous processes**, oil of turpentine, freely applied, is of great value as a non-corrosive disinfectant (G. Ross). Bonnaire and Charrier use it to disinfect the uterine cavity where iodine has failed, and Cramer lauds its local effects in **infected abortion** cases. As a hemostatic turpentine is highly recommended by G. G. Turner, especially in alarming **secondary hemorrhage** in which no bleeding point can be caught, and in **bleeding tooth-sockets**, after **vaginal hysterectomy**, etc. All blood-clots should be removed and the wound then packed with gauze that has been soaked in oil of turpentine and squeezed nearly dry.

In **tympanites** the oil may be used by rectum in amounts of $\frac{1}{2}$ to 1 fluidram (2 to 4 c.c.) in copious enemas of warm water.

Injections of turpentine are recommended in **myiasis** or **infestation** of the orifices of the body wounds with **fly-maggots**.

Hypodermic injection of 16 minims (1 c.c.) of oil of turpentine—8 minims (0.5 c.c.) in young children—usually into the cellular tissue of the abdominal wall

or thigh, has been employed, in inducing the so-called "aseptic fixation abscess," with asserted marked benefit on the general condition in a certain proportion of cases of **septicemia** and of primary **bronchopneumonia** following various infections.

Internally, turpentine is used especially in disorders of the alimentary tract and respiratory system. In the tympanites of **typhoid fever** its ingestion in 5- or 10-minim (0.3 to 0.6 c.c.) doses in an emulsion 3 times a day is advised, in conjunction with external and rectal use. The condition of the mouth is also held to be improved by it in this disease. To expell **hookworms** and **tapeworms** a $\frac{1}{2}$ -ounce (15 c.c.) dose of turpentine, combined with castor oil, is effective, though not entirely free of the possibility of untoward side-effects. Frequent small doses are often successful where a single large dose fails to destroy a tapeworm (J. D. Palmer). In **infantile digestive disorders** with flatulence and colic, Eustace Smith orders, *e.g.*, for an eight months' child, 1 minim (0.06 c.c.) of the rectified oil, rubbed up with 3 minims (0.2 c.c.) of castor oil and 2 grains (0.12 Gm.) of gum tragacanth, made up to a teaspoonful with water, and disguised with small amounts of fluidextract of licorice, oil of cloves, and chloroform. In the **abdominal cramps** of older children, the same author recommends 3 or 4 minims (0.2 to 0.25 c.c.) of the rectified oil, with or without double the quantity of castor oil, rubbed up with a spoonful of the *mistura amygdalæ* (B. P.), to be given 3 times a day. J. H. Williams finds its stimulating effect on the mucous membranes useful in **chronic catarrhal gastro-intestinal affections** in general, and also employs it in **colliquative diarrhea** in combination with bismuth salts.

In respiratory affections turpentine and its derivatives are used as antiseptics and to arrest excessive bronchial secretion, *e.g.*, in **bronchorrhea** and **fetid bronchitis**, as well as in the **bronchial catarrh** of **pulmonary tuberculosis**. In the latter condition, terpin hydrate in 2- or 3-grain (0.12 to 0.2 Gm.) doses is useful. In **pulmonary abscess** and **gangrene of the lung**, 5-minim (0.3 c.c.) doses of turpentine oil or of terebene may be given 3 or 4 times daily,

gradually increased to 10 minims (0.6 c.c.). For the bronchitis associated with bronchopneumonia, Jackson recommends terpin hydrate, with or without small doses of codeine. The irritating cough and bronchorrhea sometimes following lobar pneumonia are often allayed by 10-minim (0.6 c.c.) doses of terebene in capsules 3 times a day. In each of these conditions the drugs are frequently employed by inhalation, sometimes combined with eucalyptol and creosote, with good results. A tin or zinc respirator, containing a sponge upon which the drugs are dropped, may be used, or a teaspoonful of turpentine or terebene may be poured upon boiling water and the patient directed to inhale the vapor for 15 minutes every two hours.

In acute follicular tonsillitis oil of turpentine constitutes a beneficial, though homely and somewhat severe, local application. In hiccough 10 drops of turpentine, with 30 drops of spirit of nitrous ether in an aromatic water, exerts a striking effect (Smith). In laryngitis sicca, terpin hydrate in 3- to 5-grain (0.2 to 0.3 Gm.) doses 3 or 4 times a day has been advised.

In hemorrhagic conditions turpentine has also been credited with therapeutic power. In purpura hemorrhagica occurring in well-nourished, full-blooded children, Eustace Smith strongly recommends 2- to 4-dram (8 to 16 c.c.) doses of oil of turpentine, with an equal amount of castor oil, once daily. Slightly smaller doses are inefficient and even dangerous, as they may fail to produce a cathartic effect. In hemophilia, he states, catharsis with turpentine will sometimes arrest the bleeding where local styptics have failed. In the melena of typhoid fever and in hemoptysis, 10 or 15 minims (0.6 to 1 c.c.) may be given on sugar 3 times a day, but the effect is less certain than from the larger amounts in purpura. The drug has also been claimed of value in hematemesis, hematuria, and metrorrhagia. In hemorrhagic measles turpentine may possibly be of value.

Turpentine oil in doses of 5 minims (0.3 c.c.) 2 or 3 times a day frequently acts as a diuretic and, according to J. A. Munk, will often establish a normal flow where other diuretics have failed. As it

may irritate the kidneys in larger doses, such doses are not warranted except as an emergency measure in advanced nephritis. The drug seems useful in atonic conditions of the bladder, including the incontinence of bladder atony, and especially where long-standing, low-grade, infective inflammation exists. In pyelitis due to gravel, 10- or 15-drop doses 2 or 3 times daily after meals tend to allay the inflammatory process (Smith). In markedly chronic, painless cystitis, turpentine has been used to activate local circulation, the drug being persistently given up to slight tenesmus and augmented urination.

In infectious fevers of adynamic type, including yellow fever, turpentine has by some been considered of value as a general stimulant.

L. T. DE M. S.

TWILIGHT SLEEP. See SCOPOLAMINE.

TYPHLITIS. See APPENDICITIS.

TYPHOID FEVER.—DEFINITION.—An acute infectious endemic and epidemic disease caused by a specific micro-organism—the bacillus of Eberth and Gaffky—and characterized by a more or less typical temperature curve, enlargement of the spleen, epistaxis, roseola, iliac tenderness, diarrhea, and, pathologically, by enlargement and ulceration of the agminated and solitary glands of the ileum.

SYMPTOMS.—A typical case of typhoid fever presents a course which is quite characteristic. For several days there is a vague feeling of discomfort, slight headache, chilliness, dryness of the skin, aching, digestive disturbances, such as nausea, vomiting or diarrhea, particularly if a purgative is taken. The symptoms are generally worse in the afternoon, yet are not severe enough to entirely incapacitate the patient. The condition is often attributed to a cold or a "run down condition." As a rule, a phy-

sician is consulted on the third or fourth day of the disease. By this time the patient complains of rather severe headache, giddiness, pain in the limbs and back, chilliness, thirst and anorexia. The fever is found to be higher in the evening by a degree to a degree and a half, and higher on succeeding days. The pulse is rapid, ranging from 90 to 100; respirations accelerated, tongue furred, the skin hot and dry, and the abdomen distended, with, generally, tenderness and gurgling in the right iliac fossa. In a number of cases epistaxis is present. During the second week the symptoms become more pronounced and definite. From the seventh to twelfth day rose-colored spots appear on the abdomen and sometimes upon other parts of the body. These papules are round, slightly elevated and disappear on pressure. The tongue, which has been whitish yellow with red edges and tip, becomes dry and brown; the teeth and lips are covered with sordes; the gums often bleed on slight pressure; the bowels are distended with gas, and the diarrhea, if present, is more frequent, the stools being of an ochre color. The temperature gradually rises, preserving the same step-like course, reaching the acme toward the end of the second week. The usual range is 101° to 102° F. (38.3° to 38.9° C.) in the morning and 103° to 104° F. (39.4° to 40° C.) in the evening. The respirations are correspondingly quickened. The urine is scanty and red, owing to excess of urates.

The skin is dry, but at times bathed in perspiration, particularly toward morning. The nervous system is more or less profoundly af-

ected. The ataxia is manifested at first by a mental dullness and apathy. The tongue, when protruded on request, is not readily withdrawn; it is tremulous, as are the extremities. In severe cases, a low muttering delirium, a wakeful sleep, so-called coma vigil, subsultus tendinum and carphologia, or picking at the bed-clothes, occur. In the beginning of the third week the symptoms are aggravated, reaching the acme from the fourteenth to the twenty-first day, when a gradual improvement sets in. The morning remissions become more decided and the evening temperature lower than that of the preceding day; the stools are less in number and more normal in character; the pulse is slower and stronger; the tongue becomes moist; the patient looks brighter from day to day, sleeps better and evinces a greater desire for food. During the fourth week the temperature becomes normal and convalescence is established, lasting one or two weeks, or even longer, depending on the degree of exhaustion suffered. Even if favorable, convalescence may be interrupted by a recrudescence of the fever due to undue excitement, fatigue, or immoderate eating. These attacks generally subside under proper treatment. When the case tends to an unfavorable issue, the diarrhea continues unchecked; the abdominal pain and tympanites increase; the patient becomes more exhausted and lies motionless upon his side or back, drowsy and apathetic, uttering feeble moans; the face is flushed, the features pinched; the skin hot, the pulse fast and feeble; the teeth and tongue blackened with sordes; the special senses obtunded; the low muttering delirium gradually

lapses into coma, which terminates in death in a few hours.

Varieties of Typhoid Fever.—The disease may be so moderate that it presents few symptoms of any significance, or so severe that some grave malady other than typhoid may be suspected. In some cases even the fever may be absent, the disease manifesting itself by a general malaise with persistent intestinal irritation. In such cases a laboratory diagnosis is made. Or, the disease may manifest itself by a slight indisposition and a mild fever, the patient usually attending to his business till hemorrhage or even perforation discloses the nature of the affection. These so-called "walking typhoids" are by no means rare and present grave danger, not only because of the liability to complications, but because they are unrecognized typhoid carriers. Then there is the abortive type, ending in a week or ten days in convalescence. This type is probably caused either by an organism of low virulence or some other bacillus of the typhoid group. Of severe types the most frequent is the kind ushered in by high temperature and rapidly fatal, or that suggestive of acute meningitis.

The Temperature.—Variations in the temperature curve are frequent, especially: (1) Low irregular temperature without any tendency to progressive elevation. (2) Initial hyperpyrexia accompanied by a chill and rigor. (3) Remittent or even intermittent fever of the malarial type. (4) Initial hyperpyrexia with chills, headache and sweating closely resembling an attack of malaria, the "sudoral typhoid" of Jaccoud.

Another variation described by

Hare and Beardsley is the "pneumotyphoid" in which "the bacillus of Eberth exercises its primary influence upon the pulmonary parenchyma, producing signs and symptoms which are practically identical with those of ordinary pneumonia, even to the rusty sputum, although the usual vigor of onset, as seen in croupous pneumonia, may be absent or modified, and the onset in general more insidious. In these cases toward the ninth or tenth day the high fever falls but slightly in place of the characteristic crisis, and when diarrhea and rose spots appear the possibility of the entire illness being due to a typhoid infection comes upon the mind of even the careful physician for the first time." Hyperpyrexia may be marked, reaching 105° F. (40.5° C.), and at times 110° F. (43.3° C.), often subsiding in a few days. If the hyperpyrexia persists toward the end of the second or third week, a fatal issue may be looked for. A low range of fever generally points to a mild infection, although fatal cases have been recorded of this type. Liebermeister recorded 250 cases of what he called "afebrile abdominal catarrh," which he regarded as typhoid on account of the presence of other symptoms, such as enlargement of the spleen, roseola, etc. Similar cases have been observed by others. In the same group may be included the *Typhus leucissimus* (Griesinger), very mild and terminating in eight to fourteen days. In these, correct diagnosis depends on the Widal test. This form is important, since many cases of mild fever, occurring particularly in the country, are diagnosed as "bilious fever" or "malaria," and considerable damage

may accrue to the community from neglected water pollution.

Again, high fever may persist to the fourth, fifth and even sixth week. In such cases the infection is very severe and intestinal ulceration extensive. These are to be distinguished from cases in which continuous hyperpyrexia is due to complicating cholecystitis, pneumonia, tuberculosis or other disease. In the latter event the curve shows a sudden rise at some period in the course of the fever.

As a rule, the fever subsides gradually, by lysis. Rarely, termination is by crisis, convalescence being established at once. This possibility should be borne in mind when interpreting a sudden drop of temperature as indicative of hemorrhage or perforation.

The fever bears a fairly constant relation to the severity of the disease, excepting cases in which a low fever is the result of marked depression of the organism. The height and persistence of the fever present considerable prognostic value. Assuming an average temperature of 102° to 104° F. (38.9° to 40° C.) and an average mortality of 10 per cent., the latter rises with the former, reaching 100 per cent. in cases in which the temperature reaches 107° F. (41.6° C.) and over, or the morning temperature is over 106° F. (41.1° C.).

Chills.—Usually the onset of typhoid is merely marked by chilly sensations. In some cases, however, chills occur, and may recur throughout the course, and even during deferescence. They may, however, denote some complication, and may lead to confusion with malaria.

The Skin.—As a rule the skin is dry. In some instances sweating is

a feature; it may be quite profuse. The occurrence of fever, chills and sweats, mimics a fairly complete picture of malaria. Some authors mention a peculiar odor of the skin of a musty, semicadaverous character. Edema of the skin may occur as a result of venous stasis, nephritis or anemia. Due to poor nutrition, the nails and hair often suffer, especially the latter, and Osler mentions lines of atrophy of the skin on the abdomen and lateral aspects of the thighs similar to *linea atrophica* of pregnancy. They are possibly due to neuritis.

The rash, a diagnostic sign, develops about the seventh or the ninth day. In rare instances it occurs on the third day, and may be scarlatini-form in character. It consists of rose-colored spots, or flattened slightly raised papules, from 2 to 4 millimeters in diameter, which disappear on pressure. The spots may be few or many, and may come out in successive crops. They are usually found on the abdomen, chest, back, and sometimes the extremities and the face. In rare cases the eruption coalesces, producing the appearance of measles; in others, there is a generalized erythema, suggestive of scarlet fever. Other dermatoses are petechia; the *taches bleuâtres*, which are steel-gray spots scattered on the abdomen and supposed by some authors to be caused by pediculi; sudamina; urticaria; *tache cérébrale*, a red line produced by drawing the finger-nail over the skin, supposed to occur in meningitis, but also found in typhoid and other fevers; herpes labialis; dermatitis exfoliativa; erythema nodosum; hemorrhagic eruptions in the neighborhood of the joints; gangrene of the skin.

Bed-sores.—These are areas of superficial necrosis caused by pressure and irritating discharges. They are observed in patients who are very ill and emaciated, and who lie mostly on the back. Bed-sores are rare in patients who are properly nursed, as they can be avoided by changing the position of the patient, frequent changes of soiled linen and free use of soap and water after defecation.

The Digestive System.—At the onset the mouth is dry, the tongue swollen and furred. Later the coating is thick and brown, the tongue becoming ulcerated if the case is severe and hygiene of the mouth neglected. Such patients may suffer from stomatitis, or acute parotitis. Infection of the submaxillary glands may also occur.

A mild pharyngitis occurs at the onset of most cases. In some it becomes severe, and the palate and tonsils may become affected.

The esophagus may show inflammation of the mucous membrane, and sometimes ulceration. In a few of the recorded cases of ulceration typhoid bacilli were found in the lesions.

The Stomach.—As a rule the mild gastric disturbances depend on fever and general toxemia. In some cases, however, gastric irritation is so severe as to interfere seriously with nutrition. Typical typhoid gastric ulcers have been recorded.

The Intestines.—In the average typical case the intestinal changes follow a regular course: (1) hyperemia; (2) ulceration; (3) sloughing; and (4) cicatrization, the symptoms being pain and tenderness in the ileum, gurgling in the right iliac fossa, tympanites due to increased

bacterial action, and diarrhea. In some cases, however, there may be little or no ulceration in the intestines, and constipation may either supplant the early diarrhea or occur throughout. Often diarrhea is due chiefly to purgatives, or to improper feeding, particularly the use of broths. Diarrhea aggravates the patient's condition: (1) The withdrawal of considerable amounts of fluid causes disturbance in the circulation. (2) The contents of the colon being in a fluid state, bacterial activity is much greater, with consequent toxic absorption. (3) Secondary intoxication exerts a profound influence on the nervous system and metabolism, greatly interfering with the patient's nutrition. Very probably the vitality and resistance of the cells are lowered, ulceration is deeper and more extensive, and owing to the distention, hemorrhages and perforation are more apt to occur. With so much bacterial activity there is always a possibility of some symbiosis, which augments the virulence of the typhoid bacilli.

Meteorism is frequent, especially in cases accompanied by diarrhea. It usually occurs during the height of the disease, and indicates marked toxemia. The distention causes interference with respiration and the heart's action. In some cases it may produce intestinal paresis, establishing a vicious circle by the diminished peristalsis increasing the tympanites.

Pain.—Abdominal pain is frequent. It varies from tenderness in the right iliac fossa to generalized pain, particularly on pressure. In some cases the pain is caused by increased peristalsis, distention with gas or indigestion; in others, an enlarged spleen, or, by lesions in the gall-bladder,

lungs, pleura or abdominal viscera. The lymphoid tissue of the appendix is often involved and tenderness in this region may mislead into a diagnosis of acute appendicitis. Many unnecessary appendectomies have thus been performed. On the other hand, coincidence of typhoid fever and appendicitis is by no means impossible, and, indeed, probably occurs in numerous instances, but is overlooked.

The Rectum.—In a number of cases rectal ulceration occurs, causing slight bleeding. Perforation of a rectal ulcer has been recorded.

The Abdominal Organs.—The liver is sometimes invaded by the typhoid bacilli. It is enlarged, tender and may show focal necrosis, abscess and pyelephlebitis. In milder grades jaundice may occur—the “bilious remittent” of the older writers, a conception of the disease which still clings to some physicians.

The gall-bladder is often infected, the bacilli gaining access through the circulation. As a rule, there are no severe disturbances. In some cases, however, severe cholecystitis is ushered in, with severe pain, chills, vomiting, and sudden rise of temperature. This may subside in a few days, or perforation of the gall-bladder and peritonitis take place.

The Spleen.—Splenic enlargement is constant. It is the organ in which typhoid bacilli are invariably present, causing hyperemia and swelling of the lymphoid tissue. The enlarged organ is often tender.

The Respiratory System.—Various grades of inflammation of the upper respiratory tract are common. Hyperemia of the nasal mucosa occurs early. It may be slight, causing discharge of bloody mucus, or intense,

resulting in profuse bleeding. The pharynx and larynx may show slight catarrhal inflammation of a severe grade, causing ulceration, with its attendant symptoms. A mild bronchitis occurs almost invariably in the beginning. It may be so intense as to cause numerous râles and bloody expectoration, thus suggesting pneumonia.

Typhoid infection of the pleura has been reported. The attack differs from acute pleurisy, in that the general symptoms are out of all proportion to the local signs. In cases of effusion, the typhoid bacillus has been found in the fluid (Westcott).

The Circulatory System.—The heart shows changes peculiar to toxemia. Evidences of myocardial degeneration may occur as the disease progresses and exhaustion takes place. Endocarditis caused by the typhoid bacillus has been noted, presenting no peculiar clinical features. Thrombosis of the arteries and, more frequently, the veins occurs as a complication, usually caused by a local phlebitis.

Blood-pressure.—This is usually low, varying from 115 to 125 early in the disease and 100 to 110 later. Taken repeatedly, a systolic pressure lower than the pulse rate is an indication of cardiac weakness. A sudden drop in pressure points to hemorrhage, while a gradual rise shows improvement.

The Nervous System.—Nervous manifestations are common. Early, the pains in the back, vertigo, severe headache, insomnia and difficulty in ideation point to peripheral nervous irritation. Later, the low muttering delirium, the coma vigil, amnesia, and, at times, evidences of marked menin-

geal irritation show how profoundly the cerebrospinal centers are affected. In some cases the mental state may assume the aspect of a psychosis; many such patients have been sent to institutions for the insane. Mania, delirium accompanied by definite delusions, paranoia and melancholia have all been noted. This fact should put the physician on his guard in every case of acute insanity.

Actual meningitis in typhoid is rare, and the diagnosis of "typhoid meningitis," frequently made, is generally erroneous. Symptoms of meningeal irritation are common, and at times may be indistinguishable from those of true meningitis. The lumbar puncture clears up the diagnosis.

Also met with are cerebral thrombosis and embolism, poliomyelitis, convulsions, bulbar paralysis, epilepsy, neuritis, and various neuralgias.

The Genitourinary System.—The urine resembles that of other febrile conditions. It is usually lessened in amount, with excess of urates and pigments and high specific gravity, due to increase of urea and uric acids. Often there is a marked increase in urea nitrogen, and also in the ammonia and amido-acids, suggestive of a toxemia from cellular disintegration. In most cases, if at all severe, albumin is present. It is evanescent, and but rarely permanent. Indican is increased. In about 30 per cent. of the cases typhoid bacilli appear in the urine during the third week. Other micro-organisms may also be present, particularly the colon bacillus. These bacteria may give rise to cystitis and pyelitis.

Retention of urine is quite common at the onset. When late, it is due to

stupor; the bladder may become distended enormously without the patient complaining about it. The physician should inquire about the bladder function and ascertain if the organ is distended. In view of the usual low resistance, catheterization should be avoided as far as possible.

Incontinence of urine is most frequent in patients who are in a stupor, and may be associated with distention. Great care should be exercised in maintaining absolute cleanliness.

The reproductive organs are sometimes affected. Cases of orchitis, mastitis and ovarian abscess, caused by the typhoid bacillus, have been reported. Menstruation usually ceases; pregnancy, if present, is interrupted, if the attack is severe. "The typhoid bacillus may pass from the mother to the child *in utero*, usually in cases with hemorrhagic lesions in the placenta. The child apparently always dies of the typhoid septicemia, but does not necessarily show intestinal lesions. The agglutination reaction is not always given by the fetal blood, and if present it may have been due to changes arising in the blood of the fetus" (McCrae).

Cases of puerperal typhoid infection have been reported.

COMPLICATIONS.—The most serious are hemorrhage and perforation. **Hemorrhage** may occur early, due to oozing from the hyperemic areas. This form is not, as a rule, serious. The more severe hemorrhages occur at the end of the second and through the third week. The patient is suddenly restless and anxious, and the pulse more frequent and bounding. A hemorrhage has occurred. This may be slight, a few drams soon appearing in the stools,

or profuse, a pint or more. In the latter case the pulse becomes rapid and feeble, and a decided drop in temperature takes place. There may be only a single hemorrhage or a number of them, or the bleeding is more or less continuous. In severe bleeding the pulse becomes rapid and feeble. The blood-pressure falls to 80 or 90 mm. Hg., the hemoglobin is reduced, and the red cells may be reduced to 2,000,000 per c.m. The coagulation time is increased. If toxemia is not severe, the hemorrhage alone is not fraught with great danger. But if the patient is profoundly toxic and exhausted, a profuse hemorrhage may so affect the circulation as to prove fatal.

Perforation.—This occurs in about 2 to 3 per cent. of the cases. It results from the extension of necrosis of a typhoid ulcer; its usual site is the ileum. One should be on the lookout for it where abdominal distention, diarrhea and pain are prominent symptoms. In view of the favorable surgical results, the recognition of perforation at its earliest possible moment is of great importance. The earliest symptom is acute abdominal pain. In some cases, paroxysmal pain and tenderness may be present for several days before perforation occurs. Broadly speaking, any decided change in the condition of the patient's abdomen during the third or fourth week of the disease should be carefully scrutinized; particularly in the right lower quadrant. The principal features of perforation are thus summarized by McCrae:—

"1. *General Appearance.*—This may be suggestive at the onset, the features having a more or less pinched

expression, especially if there be sweating. As a rule this does not persist, and in a few hours later there may be nothing marked. If general peritonitis develops we have the characteristic facies of that condition.

"2. *Temperature.*—The course of this is variable. In many patients immediately following perforation there is a slight elevation, followed later by a drop. . . . A sudden fall or sudden elevation may occur with the perforation. Later on the temperature may rise with the peritonitis, but, as a rule, changes in the temperature are too uncertain to be of much value.

"3. *Pulse and Respiration.*—Usually these both show increase, but there is no certainty in this, for patients have been operated on in whom neither the pulse nor the respiration rates had especially altered. Generally the respiration rate increases at the time of perforation, and this may be a valuable sign. Later on both the pulse and respiration rate almost invariably increase.

"4. *Gastric Symptoms.*—Hiccough, nausea or vomiting may occur at time of perforation. . . . In several patients the sudden occurrence of one of these has first aroused suspicions of perforation.

"5. *Abdominal Conditions.*—These are by far the most important. . . . Abdominal pain may be fairly constant, but is usually paroxysmal. The local abdominal features are (a) increase in distention, which is often not present until some hours after perforation. It should always be carefully looked for. . . . (b) Changes in the respiratory movement: these, if present early, are very valuable. The decrease in the

extent of movement may be seen only below the navel or may be more on one side than the other. But general peritonitis may be present with well-marked retention of the respiratory movement. (c) Rigidity: this . . . should always be most carefully noted. Light palpation should be employed, and it is especially important to compare the two sides of the abdomen. With perforation it may be some hours before rigidity is marked, and too much importance should not be attached to its absence. Persistent rigidity of one rectus muscle is an important sign. (d) Muscle spasm: this is, as a rule, the most important local sign. It may be quite local and found in part of one rectus only. (e) Movable dullness: this may suggest the presence of free fluid in the peritoneal cavity, but great caution should be observed in drawing such a conclusion, as it may be given by fluid in the bowel. This is especially likely to occur if there has been diarrhea, which is often the case in the patients with perforation. (f) Obliteration of liver dullness: this is of value in two conditions; first, if it occur in an abdomen which is flat or scaphoid, and second, if it has appeared suddenly in a non-distended abdomen. . . . (g) Signs on auscultation: these are of very doubtful help. Some writers, especially the French, have laid stress on the fact that gas could be heard escaping from the bowel through the perforation. The writer heard it in one patient with perforation in whom there was also a curious sound on auscultatory percussion comparable to the coin sound in pneumothorax.

"6. *Rectal Examination.*—This should always be made. . . . If

the process be low in the abdomen there may be marked tenderness on pressure high up in the rectum, sometimes more on one side.

"7. *Bowels.*—As a rule they do not move after perforation, but this is not invariable.

"8. *Leucocytes.*—Perforation is usually followed by an increase in their number. There are three fairly well-marked groups of cases: the first, in which there is a steady increase in the number from hour to hour; the second, in which there is a slight increase in the first two or three hours and then a rapid fall, and the third, in which there is practically no change or even a fall. The initial rise may be very temporary. . . . Counts can be of service only if there are previous ones available for comparison. Many of the conditions which cause abdominal pain may also produce leucocytosis. It is in the group in which the leucocytes increase steadily that the blood-counts give the most assistance. The presence of leucocytosis is most important, but from its absence no conclusion should be drawn. A steadily dropping count may suggest a severe general peritonitis.

"9. *Blood-pressure.*—In many patients there is a sharp rise with the perforation. This is not invariable. . . . It should be of aid in the diagnosis of hemorrhage from perforation. In one patient the rise in blood-pressure occurred about three hours before the first sign of perforation.

"Advance in the signs is an important aid, and the patient should be carefully watched for this. The distention may gradually increase, the respiratory movements decrease, and

the tenderness with rigidity and muscle-spasm become more marked. But one should not wait for too much advance before deciding on exploration.

"Lastly, as an aid in the diagnosis of perforation we must include an exploratory incision, for it is well to recognize that it may be impossible to make a positive diagnosis without this. . . . In some patients, especially those who are toxic or delirious, it may be quite impossible to make an early positive diagnosis. No one can lay down rules which will always apply—every patient is a new problem. The conditions which are most likely to be mistaken for perforation are as follows:—

"(1) Peritonitis from other causes: This is not common and its definite recognition is difficult. . . . In these cases an exact diagnosis is not an important matter, because the treatment is the same as for perforation. (2) Appendicitis: This may be due to a typhoid process or may be distinct, and either acute or acute exacerbation of a chronic condition. The condition can hardly be positively recognized and the same remarks apply as to the preceding group. (3) Hemorrhage: This may give a picture much like perforation, but the fall in blood-pressure and in the percentage of hemoglobin is an aid in diagnosis. The association of the conditions has to be kept in mind and every patient with hemorrhage should be carefully examined with the possibility of perforation in view. Rigidity and muscle-spasm are not as common in hemorrhage as in perforation. In one patient of this series with both, in whom the symptoms were very severe, the fall in hemoglobin did not seem enough to

correspond to a hemorrhage sufficient to give all the symptoms. . . . (4) Phlebitis: This, in the iliac veins, may give very suspicious symptoms, and in one such case of this series exploration was done. The careful examination of the leg for swelling and the femoral region for tenderness may give the correct diagnosis. (5) Intestinal conditions, such as obstruction, strangulation, intussusception, may cause difficulty. (6) Attacks of abdominal pain without evident cause: In these patients careful continued examination should exclude them beyond doubt. Perforation of an ulcer in the stomach does not require any special discussion."

Other complications more or less serious are: Peritonitis from causes other than perforation, hemorrhagic pancreatitis, diphtheritic laryngitis, pneumonia, both lobar and lobular, hypostatic congestion of the lungs, pleuritis, endocarditis and embolism, otitis media, acute nephritis, thyroiditis, periostitis and other bone lesions, arthritis, suppuration and gangrene. Typhoid fever may also be associated with other diseases, presenting a somewhat distorted clinical picture, as malaria (rare), tuberculosis, eruptive fevers, gastrointestinal disorders, trichinosis, syphilis, gonorrhea and appendicitis.

DIAGNOSIS.—Diagnosis based on clinical symptoms presents difficulties which are at times insurmountable. A snapshot diagnosis of typhoid fever is frequently made by the thoughtless physician only to be forced to acknowledge his mistake or, else compelled to fall back on the time-honored, but dishonest misrepresentation of his ability to "abort" the disease. Again, a case of typhoid

overlooked may mean an intestinal hemorrhage or perforation when neither patient nor physician is prepared for it. As there is not a single pathognomonic symptom of typhoid fever, the attending physician should refuse to make a positive diagnosis on the first or second visit. This delay should not occasion any anxiety, since the general treatment of the patient would not materially change were the case one of typhoid. In 4 or 5 days, careful observation will generally permit of a satisfactory diagnosis, particularly in localities where typhoid is practically the only continued fever.

The signs and symptoms which are suggestive of typhoid fever are: (1) gradual onset; (2) headache and mental dullness; (3) irregular temperature with a distinct rise in the evening; (4) bronchitis, with slight expectoration; (5) epistaxis; (6) relatively slow dirotic pulse; (7) furred, tremulous tongue; (8) diarrhea; (9) enlargement of the spleen; (10) rose spots; (11) iliac tenderness; (12) hypoleucocytosis, with an increase of the mononuclears.

There are certain symptoms which are against a diagnosis of typhoid, as herpes, coryza and conjunctivitis.

The diseases with which typhoid fever is often confounded are tuberculosis, malaria, typhus fever, septic conditions, endocarditis, influenza, ptomaine poisoning, acute exanthemata, trichinosis, secondary syphilis, cerebrospinal meningitis, pneumonia, pleurisy, appendicitis, acute nephritis, and other conditions accompanied by a continued fever.

It is in the obscure cases that the laboratory methods of diagnosis are of greatest value.

The Widal test was described in volume i, page 458, and volume v, page 384, and Ehrlich's diazo-reaction, now rather discredited, in volume iv, page 109.

Prophylactic inoculation with triple vaccine (T. A. B.—typhoid and paratyphoids A and B) has wrought material changes in the 3 diseases. The symptoms have become so modified, or so many are absent which were diagnostic, that the clinical diagnosis of enteric infection has become very difficult. The agglutinin test has also been modified, but it still remains the one method of making a reasonably certain diagnosis. The technique of Dreyer and Walker, of quantitative determination of the agglutinins for each of the 3 organisms against standard agglutinable cultures, is the method to be used, but it must be carried out by an experienced worker. The test must be repeated at regular intervals to obtain the curve of each of the 3 agglutinins. A positive result is shown by a rise in the agglutinin curve for 1, or at times 2, of the organisms amounting to 100 to 200 per cent. This rise reaches its maximum between the sixteenth and twenty-fourth days of the disease. H. M. Perry (Lancet, Apr. 27, 1918).

The Bordet-Gengou Reaction.—

This is a biochemical reaction.

Five substances are required to perform the test. (a) Typhoid antigen. This is an emulsion of killed typhoid organisms. (b) The serum from a typhoid fever patient, which is heated to a temperature of 55-60° C. for half an hour. This contains the typhoid amoceptor. (c) The blood-serum from a guinea-pig. This provision is known as the complement. (d) The hemolytic serum, which is obtained by immunizing a rabbit with the red corpuscles of another animal, *e.g.*, the sheep. This rabbit's serum will then cause hemolysis of sheep's corpuscles *in vitro*. The serum is heated to destroy the complement. (e) The suspension of sheep's corpuscles in normal saline.

The first 3 substances are placed in a

sterile test-tube, which is well shaken and then placed in an incubator at 57° C. for 1 hour. The complement will be found to have united firmly to the typhoid amboceptor and typhoid antigen, which are now represented as the emulsion of typhoid organism.

The hemolytic serum, suitably diluted, and the sheep's corpuscles are then added, and the whole, thoroughly shaken. An opaque red fluid results. The tube is then placed for about 2 hours in an incubator at 57° C.; the red corpuscles will have sunk to the bottom of the tube, having undergone no hemolysis, and the fluid in the tube remains colorless.

A control is made by preparing another tube, in which the serum of the typhoid patient is replaced by that of a normal individual. Here the red blood-corpuscles are destroyed, and the solution in the tube is of a transparent red color. Hemolysis is complete because the complement, not being anchored to the typhoid amboceptor and typhoid antigen, is free to fix itself to the hemolytic amboceptor and red corpuscles.

The Ophthalmic Reaction in Typhoid.—This test was developed in 1907 by Chantemesse who claimed that it gave a very early indication of typhoid fever.

The method was subsequently modified by Floud and Barker, and by Austrian, who prepares his antigen from a mixed culture of 80 different strains. These are grown in plain bouillon for 24 hours and are then sedimented, washed and killed by heating for 2 hours at 60° C. The mass of bacilli is then thoroughly dried and ground with sodium chloride crystals in an agate mortar, after which it is macerated with water for 3 days and the watery extract precipitated by pouring into absolute alcohol. The residue is then collected, dried, pulverized, and a solution made in the proportion of 10 mg. to 1 c.c. of water. One drop of this solution dropped into the lower conjunctival sac of the typhoid patient produces reddening of the conjunctiva and sometimes slight edema of one or both eyelids. The reaction reaches its height in from 6 to 10 hours.

Isolation of Typhoid Bacilli from Body Fluids.—It has become possible to isolate typhoid bacilli from the blood, feces, urine, rose spots, and spinal fluids. In some cases a blood-culture may prove of great diagnostic value, particularly in differentiating typhoid fever from other bacteremias. In such cases the clinician may make the initial culture and turn it over to the bacteriologist for further study. The technique is thus described by Hektoen:—

"The best method to secure blood for bacteriological study is venous punctures under the most scrupulous asepsis. Naturally, glass syringes are preferable to metallic because more easily sterilized and because transparent. . . . By some it is regarded as sufficiently cleansing to wash the area about the puncture with alcohol or ether. In practically all cases one of the veins at the elbow, usually the median, is selected for the puncture, and a moderate constriction of the arm will distend them. . . . In fleshy persons . . . it may be necessary to make the puncture more or less blindly.

"Immediately on withdrawal of the needle, after filling the syringe, suitable media should be inoculated with the blood before clotting takes place. In most cases it will probably be deemed most advantageous to inoculate small quantities of the blood, *e.g.*, 1 c.c., into large quantities of some liquid medium like bouillon, *e.g.*, 100 c.c. The main reason for this dilution is the necessity to overcome, as far as possible, the natural bactericidal properties of blood, at least for some bacteria.

"During the process of inoculating flasks . . . the mouth of the uncorked flask should be held in such a way that bacteria cannot fall in . . . Undoubtedly organisms sometimes are picked up from the deeper layers of the skin as the needle passes through. In most instances the contaminating organisms will be found to be vulgar staphylococci, and it will be a safe rule to place no significance on the development of growths of staphylococci, especially

other than *Staphylococcus pyogenes aureus*, in cultures from the blood.

"The inoculated flasks are then placed in the incubator for 24 to 48 hours, when they are examined for turbidity and other evidences of bacterial growth. When the bouillon remains sterile the blood-corpuscles fall to the bottom intact, the supernatant fluid becoming clear, or nearly so. In the case of streptococci a frequent early evidence of growth is diffusion of hemoglobin, i.e., laking of the blood owing to the development of a special hemolytic substance . . . Typhoid bacilli usually cause a diffuse turbidity of bouillon in 24 to 48 hours. In order to secure easily sufficient material for microscopic examination and for subcultures from flasks of blood-cultures the use of long sterile pipettes is very convenient."

A new method for the isolation of typhoid bacilli from the blood has been devised by Cole, Davison, and Cronk. In it the disturbing bactericidal power of the blood is eliminated by the employment of typhoid bacilli killed by heating, or the filtrate from typhoid cultures after autolysis. Wright and others have shown that the specific amboceptors are absorbed by such dead bacilli or their receptors. This practical application of this principle permits of isolation of typhoid bacilli from the blood in about 70 per cent. of the cases. Only 1 c.c. of blood is required, easily obtained in a syringe and added to 10 c.c. of the media. This greatly simplifies the use of blood-cultures.

The isolation of typhoid bacilli from the feces, urine and other fluids requires special media. The Hiss plating medium consists of 10 Gm. of agar, 25 Gm. of gelatin, 5 Gm. of sodium chloride, 5 Gm. of Liebig's beef-extract, 10 Gm. of glucose, and 1000 c.c. of water. The reaction is 2 per cent. of normal acid. The typhoid bacillus is distinguished by the appearance of the colonies and the non-formation of gas. In a tube medium of similar composition, but with less agar and more gelatin, the typhoid bacillus produces a uniform cloudiness in 18 hours, without gas formation. Drigalski and Conradi introduced a differentiating medium by modifying the ordinary lactose litmus

agar by the addition of nutrose and crystal violet. The latter inhibits the growth of many other bacteria. On this medium, typhoid colonies are blue. The "endomedium" appears to be gaining favor among bacteriologists. This medium is made up of 10 Gm. of extract of meat, 10 Gm. of peptone, 5 Gm. of sodium chloride, 40 Gm. of agar, 5 Gm. of lactose, 5 c.c. of a 10 per cent. alcoholic solution of fuchsin, and 25 c.c. of a 10 per cent. solution of sodium sulphite. The colonies of typhoid bacilli on this medium are colorless, while those of the colon bacilli are red.

ETIOLOGY.—The *typhoid bacillus* was discovered by Eberth in the spleen and mesenteric glands of typhoid fever patients in 1880. In 1884 Gaffky established definitely its etiological responsibility and obtained pure cultures of it.

The bacillus is a short, somewhat slender rod, with rounded ends, actively motile and possesses a number of peripheral flagella. It stains readily with the usual aniline dyes, and is decolorized by Gram's method. It is facultative aerobic and grows well in ordinary culture media.

Bouillon.—Uniform cloudiness without the formation of a pellicle.

Gelatin.—Characteristic leaf-shaped colonies. No liquefaction. In stabs, growth along entire extent of stab with thin surface growth.

Potato.—Barely visible, moist, glistening growth.

Milk.—No coagulation. Litmus milk turned red.

Dunham's Peptone Solution.—No indol produced.

Sugar Broths.—No gas. Formation of acid in all sugars, except lactose and saccharose.

The typhoid bacillus grows well at room temperature, but most luxuriantly at 37.5° C. Its thermal death

point is 56-60° C. for 10 minutes. It remains alive on culture media for years, in natural waters for about a month, and in ice for 3 months.

When injected into the lower animals a fatal septicemia may be produced, but no typical pathological changes. In man definite lesions are produced, and the bacilli pass into the blood-stream and thence to other tissues. They are eliminated with the various secretions and disappear from the body in 4 or 5 weeks. Occasionally they remain in the body for months, and even years, the resulting "typhoid carriers" being of great epidemiological importance.

The effect of the germ is due to endotoxins set free by its destruction. Robust subjects often suffer from greater toxemia than weak, because of the more rapid destruction of bacilli and vigorous liberation of endotoxins taking place. These stimulate the production of immune substances in the blood-serum, bactericidal and bacteriolytic, agglutinating and precipitating, *i.e.*, killing, dissolving, agglutinating or precipitating typhoid bacilli in contact with them. Their exact nature and origin remain unknown. They are certainly different from the antitoxic principles produced in response to the irritation of soluble toxins, as in diphtheria and tetanus. And it is for this reason that an antityphoid antitoxic serum, like the serum against diphtheria or tetanus, is not a rational agent.

There are various other bacteria which commonly invade the intestinal tract, and are so closely related as to suggest some common progenitor, if not a possible mutation. Thus, the colon bacillus has been shown closer to the typhoid bacillus than

supposed. It was demonstrated by Sallus that the colon bacillus forms the same aggressins as the typhoid. The group includes the colon bacillus, the typhoid, paratyphoid, the dysentery bacillus, and *Bacillus fecalis alkaligenes*. Closely related to this group is the *Bacillus lactis aerogenes*, an ordinary saprophytic organism.

A number of these organisms may produce a disease which, but for the absence of the specific agglutination reaction against typhoid bacilli, might be mistaken for typhoid. The organisms of the enteritidis group cause severe gastrointestinal symptoms, characterized by profound toxemia. *Bacillus coli communis* (colon bacillus) is a normal resident of the intestinal tract of man and animals, but under certain conditions of virulence and susceptibility is capable of producing severe pathological changes. *Bacillus fecalis alkaligenes* resembles the typhoid bacillus very closely, but is only slightly pathogenic. *Bacillus enteritidis*, or the meat-poison bacillus discovered by Gärtner, is also closely related.

The following grouping based on cultural characteristics is given by Dunham:—

DIVISION I.—Typhoid-like morphology (motile).

A. No sugars fermented. Type *B. fecalis alkaligenes*.

B. Acid in dextrose, but no gas. Type *B. typhosus*. Agglutination in typhoid serum.

C. Acid in dextrose, but gas only when other constituents are favorable. No acid or gas from lactose or saccharose. No agglutination in typhoid serum. Includes *Bacillus "Gwyn"* and *Bacillus "O"* of Cushing.

D. Acid and gas from dextrose. No acid or gas from lactose or saccharose. Grows more rapidly than typhoid. No agglutina-

tion in colon-immune serum. Slight reaction with some typhoid sera. Includes Gartner's *B. enteritidis*, *B. Morseele*, Gunther's meat-poisoning bacillus, hog-cholera bacillus, *B. psittacosis*, *B. morbificans bovis*, Durham's *Bacillus "A," B. typhi murium*.

DIVISION II.—Colon-like morphology (motile).

E. Acid and gas from dextrose; none from lactose or saccharose. Rate of growth and colony appearance more like colon than typhoid.

F. Acid and gas from dextrose, and no gas from lactose. Types isolated by Durham.

G. Acid and gas from dextrose; acid, no gas, from lactose. Differ from F in serum reactions.

H. *B. coli communis*. Acid and gas from dextrose and lactose; none from saccharose.

I. *B. coli communior*. Acid and gas from dextrose, lactose, and saccharose.

DIVISION III.—Non-motile. Polysaccharide splitters (starch). Type *B. lactis aerogenes*. Includes bacilli of *mucosus capsulatus* group and Friedländer's bacillus.

The *Bacillus dysenteriae* differs from the typhoid bacillus in being very slightly motile, slightly in cultural behavior, and in the absence of the specific agglutination reaction. Several varieties of it have been described which ferment certain sugars.

The paratyphoid bacilli are organisms belonging either to the enteritidis groups or the psittacosis group, which produce a disease resembling typhoid. The serum reaction is frequently the only means of differentiation from true typhoid.

The other factors which enter into the etiology of typhoid fever are:—

1. *Sex.*—The disease is more prevalent in males.

2. *Age.*—Typhoid is rare under 2 years, and most common between 20 and 30. It may occur at any age.

3. *Predisposition.*—Bodily vigor does not confer immunity against ty-

phoid. On the contrary, the robust frequently succumb to it. The possibility of infection is greater among those in contact with the patients, as physicians and nurses, and among the poor when proper isolation is not possible.

4. *Season.*—Typhoid is most prevalent in early autumn, possibly because this is usually the vacation season when many persons go to the country.

5. *Distribution.*—Typhoid fever is not bound by any geographical limits. It occurs in the tropics and far into the North. However, in cities in which the water-supply is pure and the sewage properly disposed of, its incidence is reduced to a minimum, or what is known as "residual typhoid."

PATHOLOGY.—Typhoid fever may be said to be a constitutional disease with local manifestations, very much like diphtheria, except that the former is a bacteremia. The intestinal changes are general and specific, the former comprising a catarrh of the small and large intestines associated with epithelial desquamation. The specific changes affect the intestinal lymphoid elements and are best described in stages: *First week*—(a) Hyperemia and swelling of the ileum. (b) Marked enlargement of Peyer's patches and solitary follicles which steadily increase, forming, finally, large smooth elevations; the original hyperemia disappears from the patches and they become whitish in color. *Second week*—(a) Anemic necrosis of the lymphoid tissue, due to circulatory obstruction. (b) Exfoliation of the mucosa. (c) Formation of sloughs and ulcers. *Third week*—(a) Development of granula-

tion tissue. (b) Growth of epithelium over the areas of necrosis. (c) New formation of glandular elements. (d) Complete healing of the ulcers.

The typhoid ulcer is situated on the surface of the intestine opposite to the mesenteric attachment. Its long axis lies in the long axis of the intestine. This location is important because contraction of the cicatrix does not, therefore, cause stricture of the intestine. The edges of the ulcer are sharply cut and the floor is formed by the mesenteric mucosa. Ulcers of the solitary follicles are not confined to the surface opposite the attachment of the mesentery. Extending through the muscular wall, an ulcer may invade one of the arteries and lead to a severe hemorrhage. Further extension may perforate the intestinal wall. Resulting escape of intestinal contents is invariably followed by fatal peritonitis.

HISTOLOGY.—The cellular increase in the Peyer patches and solitary glands is due to endothelial proliferation in the lymph-spaces, capillaries and lymphoid tissue caused by the irritation of the typhoid toxins. The cells are large, with pale-staining nuclei, abundance of acidophilic protoplasm, and are phagocytic. By blocking up the lymph-channels, they produce thrombosis of the capillaries and local necrosis. The typhoid ulcer is thus a coagulation necrosis caused by thrombotic ischemia.

The mesenteric lymphatics, spleen, liver, larynx and other organs may be the seat of typhoid ulcers. The spleen may show infarction, may become ruptured or gangrenous. The liver shows cloudy swelling, with areas of coagulation necrosis. The

kidneys may undergo albuminoid degeneration, due to the typhoid bacteria or their toxins. The abdominal muscles and the adductors of the thighs are commonly the seat of hyaline degeneration, the heart-muscle of cloudy swelling. Degeneration also occurs in the bone-marrow.

The Blood in Typhoid Fever.—The alkalinity of the blood is diminished. The coagulation time is diminished in the early stages and increased during convalescence. This increase, which may depend on the increase of calcium salts in the blood of patients who subsisted chiefly on a milk diet, is frequently the cause of thrombosis. To prevent this, Wright and Knapp advise addition of sodium citrate to the milk (20 to 40 grains—1.3 to 2.6 Gm.—to the pint—500 c.c.) as soon as the danger from intestinal hemorrhages is over. During the first week there is a diminution in the hemoglobin, but the red cells remain normal. In the second week the cells gradually diminish, the anemia corresponding to the severity of the disease. The leucocytes are decreased after the first week, the lowest level being reached during the fifth or sixth week, after which they increase. In some cases, however, a leucocyte count of 10,000 per c.m. may occur, due to concentration of the blood through diarrhea, sweating, vomiting or cold baths. Of course, if a complication occurs, hyperleucocytosis takes place, if the patient's vital powers are sufficiently strong to react. Where hemorrhage or perforation fails to cause a hyperleucocytosis, the prognosis is extremely grave, and, in perforation, the probability of relief from surgical intervention very doubtful.

Qualitative leucocytic changes are noted during the third week, progressive decrease of the polymorphonuclear neutrophiles and consequent increase in the mononuclear forms taking place. The eosinophiles are almost invariably decreased; also the blood-plaques. Myelocytes are found in severe post-typhoid anemia.

Typhoid bacilli are found in the blood in practically all cases. Their appearance there coincides with the onset, and they may be frequently demonstrated before the serum reaction develops. With defervescence the bacilli disappear, but reappear with a relapse.

PROGNOSIS.—There is no patient so well but may die as a result of some complication; there is none so ill but may recover. From 5 to 10 per cent. of the cases will succumb, no matter what the treatment. Nevertheless, the outlook in a case does depend on the care in treatment. A patient whose case is diagnosed late, who receives an abundance of drugs which either depress the heart or disturb digestion, and who is carelessly nursed, does not have good chances of recovery. Vital resistance also plays an important rôle. Unfortunately, we have no means of accurately gauging this resistance to bacterial toxins. The factors which influence the prognosis unfavorably may be summed up as follows:—

Age.—From 25 to 40 and above.

Habits.—Alcoholism, dissipation.

Severity of the Infection.—Hyperpyrexia, delirium, coma, and tremor appearing early; scanty urine; meteorism; exhaustion; a rapid pulse (above 120); feeble first heart sound; persistent diarrhea; stupor, or nervous disturbances; gastric irritation.

Complications.—Hemorrhage, perforation, pneumonia, nephritis, thrombosis, etc.

Sudden death may occur as a result of acute dilatation of the heart, delirium cordis and embolism.

Perforation.—Recovery without operation is extremely rare. When operation is resorted to before general peritonitis sets in, the result depends on the condition of the patient at the time, the toxemia, the intestinal lesions and the kind of micro-organism which escapes into the peritoneal cavity. If toxemia is marked, the bowels extensively necrosed, or the escaping contents contain streptococci, the prognosis is grave, notwithstanding early operation.

Relapse.—Defervescence is sometimes suddenly interrupted by a rise of temperature and recurrence of typhoid symptoms; or the temperature may remain normal for a week, and even longer, when the relapse occurs. Relapse is difficult to explain on any accepted theory of immunity. If recovery depends on the development of immunity, the latter should protect the individual against reinfection. It is probable, as suggested by Durham, that a relapse is due to infection with another variety of a typhoid organism against which the typhoid patient has not become immunized.

As a rule, if the primary attack of typhoid fever is mild, the relapse is severe, and *vice versâ*. The mortality in relapse is never as high as in the primary attack, hemorrhage and perforation being less common.

TREATMENT.—The main factors in the treatment are careful nursing and well-regulated diet. Treatment may be divided into five heads:—

1. Diet and general management.
2. Hydrotherapy.
3. Medicinal.
4. Vaccine and serum treatment.
5. Treatment of complications.

1. Diet and General Management.

—The patient should be put to bed in a warm, well-ventilated room. He may, in summer, be kept out-of-doors. Ornaments, flowers, bric-a-brac, etc., should be banished, especially if the patient be delirious. Careful nursing is absolutely essential. The nurse should record (1) the daily quantity of urine; (2) the temperature, pulse, and respirations; (3) the number and character of bowel movements; (4) the quantity of fluid intake; (5) anything of special interest.

A **purge** may be given at the onset of the disease; thereafter the bowels should be kept open—moving at least every second day—with **enemata**. Later, if they become sluggish, **cottonseed oil**, 4 or 6 drams (16 or 24 c.c.), may be given, and as convalescence proceeds, a gentle laxative.

The patient should be kept as well nourished as possible during the course of the disease. Carbohydrates should be freely given, to save the proteids. The patient should immediately be put upon a **liquid diet**, of which milk forms the main, though not necessarily the only, component. The criterion is the state of the digestion. In recent years greater liberality has been practised. Cream, ice-cream, calf's foot jelly, broth, albumin-water, raw or soft-boiled eggs, strained soups, junket, etc., are permissible. Alcohol, as a rule, is an unnecessary adjunct to the diet. With the first signs of distention or

of curds in the stool the milk should be stopped for from 24 to 36 hours. In convalescence the diet is slowly increased.

The following lists are offered as sample diets given to patients throughout the course of illness:—

OUTLINE OF AVERAGE TYPHOID DIET.

Breakfast, 6 A.M.: Farina 1 portion, with lactose 1 oz. and cream 1 oz. Coffee 6 oz., with cream 1 oz. and lactose $\frac{1}{2}$ oz.

8 A.M.: Hot milk 6 oz., with cream 1 oz. and lactose $\frac{1}{2}$ oz.

10 A.M.: Cocoa 1 cup (8 oz.), with cream 1 oz. and lactose $\frac{1}{2}$ oz. Bread and butter 1 slice.

Dinner, 12 M.: Broth 8 oz.; bread and butter (in form of milk toast), 1 slice of bread with milk 4 oz. and cream 1 oz. and lactose $\frac{1}{2}$ oz.; egg (poached) 1; rice 1 portion, lactose 1 oz. and cream 1 oz.

2 P.M.: Ice-cream 1 portion; bread and butter 1; milk 6 oz., with cream 1 oz. and lactose $\frac{1}{2}$ oz.

4 P.M.: Orangeade 8 oz., with egg 1, and lactose $\frac{1}{2}$ oz.

Supper, 6 P.M.: One of the wheat breakfast foods 1 portion, with cream 1 oz. and lactose 1 oz.; bread and butter 1; egg 1; malted milk 2 oz., with milk 6 oz., cream 1 oz. and lactose $\frac{1}{2}$ oz.

8 P.M.: Orangeade 6 oz., with egg-albumin 1 oz. and lactose $\frac{1}{2}$ oz.

• 12 P.M.: Hot milk 6 oz., with cream 1 oz. and lactose $\frac{1}{2}$ oz.

4 A.M.: Lemonade 6 oz., with egg-albumin 1 oz. and lactose $\frac{1}{2}$ oz.

OUTLINE OF A MORE LIBERAL TYPHOID DIET.

Breakfast, 6 A.M.: Farina 1 portion with lactose $1\frac{1}{2}$ oz. and cream $1\frac{1}{2}$ oz.; bread and butter 2 (without crust); egg 1; coffee 5 oz., with cream $1\frac{1}{2}$ oz. and lactose 1 oz.

8 A.M.: Hot milk 6 oz., with cream $1\frac{1}{2}$ oz. and lactose $\frac{1}{2}$ oz.

10 A.M.: Malted milk 2 oz., with milk 6 oz., cream $1\frac{1}{2}$ oz. and lactose 1 oz.; bread and butter 2.

Dinner, 12 M.: Broth 8 oz.; bread and butter (in form of milk toast) 2, with milk 6 oz., cream $1\frac{1}{2}$ oz. and lactose 1 oz.; eggs (poached) 2; rice 1 portion, with cream $1\frac{1}{2}$ oz. and lactose $1\frac{1}{2}$ oz.

TABLE 1.—TOTAL CALORIES PER DAY ON AVERAGE TYPHOID DIET.

<i>Food Substance.</i>	<i>Amount.</i>		<i>Calories.</i>
Cereal	3 portions	at 160	480
Lactose	8 oz.	at 125	1,000
Cream	10 oz.	at 70	700
Bread and butter (without crusts) ...	4 slices	at 87	348
Eggs	3	at 60	180
Egg-albumin	2	at 40	80
Cocoa	1 cup (8 oz.)	at 180	180
Milk	28 oz.	at 20	560
Ice-cream	1 portion	at 90	90
Broth	8 oz.	at 7	56
Malted milk	2 drams	at 120 (per oz.)	30
Total calories			3,704

TABLE 2.—TOTAL CALORIES PER DAY ON LIBERAL TYPHOID DIET.

<i>Food Substance.</i>	<i>Amount.</i>		<i>Calories.</i>
Cereal	3 portions	at 160	480
Lactose	10 oz.	at 125	1,250
Cream	16 oz.	at 70	1,120
Bread and butter	12 slices	at 87	1,044
Eggs	5	at 60	300
Egg-albumin	2	at 40	80
Cocoa	2 cups (16 oz.)	at 180	360
Ice-cream	1 portion	at 90	90
Milk	36 oz. (6 cups)	at 120 (per cup)	720
Broth	8 oz.	at 7	56
Malted milk	2 drams	at 120 (per oz.)	30
Total calories			5,530

2 P.M.: Ice-cream 1 portion; bread and butter 2; milk 6 oz., with cream $1\frac{1}{2}$ oz.

4 P.M.: Orangeade 6 oz., with egg 1 and lactose $\frac{1}{2}$ oz.

Supper, 6 P.M.: Wheat breakfast-food 1 portion, with cream $1\frac{1}{2}$ oz. and lactose $1\frac{1}{2}$ oz.; bread and butter 2, egg (scrambled) 1, cocoa (2 cups) with cream 2 oz. and lactose 1 oz.

8 P.M.: Orange-albumin (white 1 egg), with lactose $\frac{1}{2}$ oz.

12 P.M.: Hot milk 6 oz., with cream 2 oz.

4 A.M.: Orange- or lemon- albumin (white 1 egg), with lactose $\frac{1}{2}$ oz.

The following foods are recommended for appropriate cases:—

For practical purposes, the milk-sugar may be measured in a medicine glass. Each measured ounce weighs 18 Gm.. If milk-sugar is added to water in the proportion of 24 Gm. to 30 c.c. and the water

brought to the boiling point, the milk-sugar is completely dissolved.

According to the lists the patient is fed once in 2 hours, from 6 A.M. to 8 P.M. and during the night at 12 P.M. and 4 A.M.; 3 times a day, the feeding is amplified so as to resemble a meal. In their application the cereal was varied, the newer partially prepared and more palatable cereals being introduced, to the great relief of the patient. In the interval feedings highly nutritious articles were chosen, and particularly those with high carbohydrate value. Thus, milk, cocoa, coffee, to each of which was invariably added $\frac{1}{2}$ ounce of cream and $\frac{1}{2}$ ounce of lactose, were given. Also orangeade or lemonade with egg-albumin could be made into drinks carrying considerable caloric value by the addition of lactose and cane-sugar. Burrill B. Crohn (Jour. Amer. Med. Assoc., Jan. 27, 1912).

TYPHOID FEVER (ROSEN).

FOODS AND THEIR CALORY VALUE.

Name.	Amount.	Calories.
Apple sauce	1 ounce	30
Bread	Average slice (33 grams)	80
Butter	pat ($\frac{1}{2}$ ounce)	80
Cereal (cooked)	heaping tablespoonful ($1\frac{1}{2}$ ounces)	50
Crackers	ounce	114
Cream (20 per cent.)	ounce	60
Egg	(2 ounces)	80
Egg, white	1	30
Egg, yolk	1	50
Lactose	1 tablespoonful (9 grams)	36
Milk (whole)	1 pint (350) 1 ounce	20
Potato (whole)	1 medium	90
Potato (mashed)	1 table-spoonful	70
Rice (boiled)	1 tablespoonful	60
Sugar, cane	1 lump	16
Sugar, milk	1 tablespoonful	36
Toast	Average slice	80

The following diet is given by Grandy:

1. Fluid. 2. Milk, buttermilk, malted milk, whey, junket, plain ice-cream, blanc-mange, milk-toast (without crust), soft crackers, cocoa, broths, rice, lactose, eggs (soft boiled or raw), finely minced chicken.
3. Steak, chop, white meat or chicken (in small quantities), toast, bread, cereals, crackers, eggs in any form, mashed potatoes, tomatoes (strained), stewed fruits, oysters. Patients must be told to chew all food well. He generally starts the patient on milk for a day or two and then adds one extra article to the diet daily, watching the symptoms. Thus he first adds a heaping teaspoonful of milk-sugar to each glass of milk; next day, an ounce of cream, bringing up calories to 2000 a day, or if he adds two tablespoonfuls of milk-sugar to each glass, which is seldom objectionable, he gets 2400 calories a day. Next he adds milk-toast or crackers, using the same preparation of milk, milk-sugar and cream to moisten, though Grandy never objects to the patient eating these articles dry if the crust is cut from the bread. Then bread and butter are added; then eggs either raw, soft-boiled or in a custard made with milk-sugar, such a custard made after Coleman's recipe amounting to 360 calories, or a raw egg can be stirred in a cup of cocoa. Sweeten everything with milk-sugar, thus giving much nourishment without making it nauseat-

ingly sweet. Thus, a saucer of ice-cream can be made to give 500 calories and an orange-albumin raised from 50 to 100 calories or more. Sandwiches of scraped beef or finely cut chicken can often be advantageously given. With the above diet Grandy has had little emaciation, no hunger, shorter convalescence, and an apparent avoidance of relapses.

2. Hydrotherapy.—Internal hydrotherapy is effectively used in almost any fever. External hydrotherapy, however, finds a field peculiarly its own in typhoid: (1) cold sponge; (2) cold packs; (3) cold baths.

Cold Sponge.—The water may be tepid, cold, or ice cold, according to the patient's temperature. In some cases of high fever the desired reaction may be obtained with tepid sponges when the iced sponge fails. The sponging should be continued for 15 to 20 minutes, accompanied by active friction. The iced sponge is the most generally used form.

Cold Pack.—This is rarely used except where there are pronounced nervous symptoms and a tub is not available. The patient is wrapped in a sheet wrung out in water at 60° to

Cold Bath.—The patient is completely immersed, except for his head, in water of a temperature between 70° and 85° F. He remains in the tub for 15 to 20 minutes, and then is taken out, placed on a dry sheet, and covered with a blanket. A stimulant is often administered after the bath.

In the **Murphy treatment**, the Fowler position is not used, the patient being kept flat. The fluid used is **sodium chloride**, 1 dram (4 Gm.) to the pint (500 c.c.). An ordinary rectal nozzle is inserted into the rectum, and the fluid allowed to flow steadily through the day and intermittently through the night. About 2 quarts in 12 hours are used. The advocates of this treatment claim that, while it does not shorten the disease, it promotes diuresis, lessens toxemia, and renders delirium rare.

Cold colon flushings for the reduction of temperature are recommended by Penoyer. A small rectal tube is inserted and from 1 to 3 pints of water at 40° to 50° F. passed in small quantities and allowed to return through the tube. This may be repeated every 4 to 6 hours.

External hydrotherapy is usually applied when the patient's temperature is 102.5° F. (39.2° C.) or over. The rectal temperature is taken immediately after the application, and again $\frac{3}{4}$ hour later. The contraindications are peritonitis, hemorrhage, phlebitis, severe abdominal pain, and great prostration.

3. Medicinal Treatment.—Year by year this is less important. There is no specific drug treatment, but it is usually advisable to give **urotropin** after the second week. During the

ical effect. Antipyretics are, as a rule, to be avoided. Occasionally 1 or 2 doses may be of some value. **Quinine**, while it is of doubtful value, is widely used. The writer is not in accord with the usual attitude toward intestinal antisepsis. The cases with constipation, generally mild, require no special treatment except "bread pills" or their equivalent. With the patients with diarrhea, the proposition is altogether different. Here we have a colon full of liquid contents, and with many organisms causing active putrefactive changes in the favorable medium. To the typhoid toxemia there is added a bacterial intoxication due to the associated micro-organisms. While it is freely admitted that it is impossible to sterilize the intestine, mesenteric glands, spleen or blood-stream, it does appear rational to minimize the intestinal putrefaction and fermentation. Clinical observations establishing the validity of certain drugs in the reduction of intestinal putrefaction have been questioned by investigators and laboratory workers, on the ground that, to produce intestinal antisepsis a drug must be given in doses that are poisonous. Actual clinical results, however, show that, for some unaccountable reason, certain drugs act in the body as powerful germicides, even in small doses. Quinine destroys plasmodium malariae, yet is at best feebly antiseptic. Ipecac in tropical dysentery and thymol in hookworm disease certainly prove the efficacy of intestinal antiseptics when applied to parasites. Observing how bacteria are affected by even slight changes in the reaction

of the medium, we can readily admit the possibility of a certain degree of intestinal antiseptics. **Guaiacol carbonate**, probably the most satisfactory drug, may be employed in large doses, 2 to 5 grains (0.13 to 0.3 Gm.) every 3 hours. In combination with **powdered charcoal**, in **konseals**, it not only allays putrefaction, but helps to reduce meteorism:—

℞ *Sodii citratis*,
Guaiacolis carbonatis,
Pulveris carbonis animalis,
 āāgr. iij (0.2 Gm.).

M. et ft. **konseal** nu. j.

Sig.: One in water or grape-juice every 3 hours.

Lactic acid bacilli, either in **fermented milk** or in liquid culture, offer another very excellent method of inhibiting putrefactive bacteria.

4. **Vaccine and Serum Treatment.**—Vaccine and serum therapy have yet to prove their value. They offer no advantage over the ordinary treatment.

5. **Treatment of Complications.**—In **toxemia**, **water** should be given freely by the mouth, if possible; if not, by the bowel. External **hydrotherapy** should be instituted immediately. **Alcohol** may be used advantageously. **Headache** and **delirium** may be relieved or prevented by an **ice-bag** or **cold compresses** to the head. **Morphine** is sometimes necessary to quiet **delirium**. **Lumbar puncture** is also useful. The greatest aid in the treatment of *nervous complications* is **hydrotherapy**, both external and internal. For *pain* and *tympanites*, **fomentations** and **turpentine stupes** are indicated. **Turpentine** may be given by mouth, in doses of 15 minims (0.8 c.c.), and also by **enemata**. For the relief of **gas** in the

large bowel, a **rectal tube** may be passed. If a severe **diarrhea** occurs, a **starch** and **opium enema** may be given. Or, instead, a combination of **bismuth**, **opium**, and **acetate of lead** may be given by mouth. An **ice-bag** or **cold compress** to the **abdomen** relieves *pain* accompanying **diarrhea**.

For *constipation*, **enemata** are the best treatment. Unless contraindicated, the bowels should be moved at least every other day. Addition of ½ ounce (15 c.c.) of **turpentine** to an enema often relieves *meteorism*.

In *hemorrhage* absolute **rest** in bed must be imposed. The greatest care should be exercised, even in the use of a bed-pan. **Ice** may be given by mouth. A light **cold compress** should be placed on the **abdomen**. Stimulate if necessary. **Hypodermoclysis** and **transfusion of blood** may be tried if the hemorrhage be large. Some authorities warmly recommend **turpentine**. A high **rectal injection** of **normal saline solution** may be employed. **Gelatin** may be given by mouth or sterile tetanus-free gelatin hypodermically. **Calcium lactate** in doses of 15 grains (1 Gm.) every 4 hours is valuable. Opiates should not be given, as they would obscure the symptoms of perforation, and also favor **tympanites**.

In *perforation* and *peritonitis* the only hope is early diagnosis and operation. **Operate** without waiting for *peritonitis* to make the diagnosis certain. *Peritonitis* diminishes the chances of recovery by one-half. Patients stand **laparotomy** well; so in doubtful cases it is best to operate.

A majority of the cases of **cholecystitis** recover. **Urotropin** and **vaccines** are indicated in chronic cases. These failing, **operation** is advisable.

For *phlebitis*, set the limb at rest and wrap in raw cotton. Ichthyol is often of service. A sedative lotion will relieve pain.

Urotropin in 10-grain (0.6 Gm.) doses usually clears up cases of *bacilluria*. If *orchitis*, *mastitis*, *parotitis*, etc., occur, an ice-bag should be applied. At the first signs of suppuration, incise and drain.

If *bone-lesions* complicate the disease, the **vaccines** are worthy of a trial, and if they fail, **operation** is the only hope. Typhoid periostitis does not always result in suppuration, but, as a rule, requires operation. In *typhoid spine fixation* is indicated.

Bed-sores can be avoided by careful nursing. All the parts should be absolutely clean and dry. The sheets should be unwrinkled. The back should be sponged with alcohol. Pressure should be avoided by the use of rubber rings.

Treatment of Convalescence.—The convalescent acquires a ravenous appetite. As a rule, no solid food should be allowed for at least ten days after the temperature has returned to normal. If given too soon, it may give rise to a slight fever, called the "febris carnis." The patient may sit up at the end of the first week of convalescence. Emotional disturbances should be avoided, as they may cause recrudescence. *Protracted diarrhea* may retard recovery. In these cases, restrict the diet and give large doses of **bismuth**. An **astringent injection** may be employed. The treatment of a relapse is that of the exciting cause.

Cases of *post-typhoid insanity* in the hands of an expert usually recover. If *phlebitis* has occurred, an **elastic stocking** should be worn dur-

ing the day. If the collateral circulation is good, the swelling will disappear, but in most cases there is a permanent disability. Cases of *post-typhoid neuritis* usually recover, at times, only after months or years. **Massage** of the paralyzed and atrophied muscles is certainly the best treatment.

The treatment of *typhoid carriers* is difficult. **Urotropin** should be given persistently, and in large doses. **Drainage** of the gall-bladder will cure some cases. The **vaccines**, however, offer the best chances. Increasing doses are given at intervals of 10 days, starting at 25 to 1500 million.

THE PUBLIC HEALTH ASPECT OF TYPHOID FEVER.—Typhoid presents one of the most serious problems before a community. It is the disease most often caused by sewage-polluted water, and next to tuberculosis and pneumonia is the principal cause of sickness and death. There occur annually in the United States about 50,000 deaths from typhoid fever, the estimated number of cases being at least 500,000.

The bacillus of typhoid is taken in with food and drink which contain it, and is excreted from the body of the typhoid-fever patient with the feces. The latter gains access to the nearest water-supply and the typhoid bacilli infect the water. Precisely in this way epidemics originate in towns and cities which are obliged to drink the sewage of other municipalities located on their watershed. Of course, there is always a possibility of direct infection by coming in contact with the patient's feces or urine, but epidemics cannot thus arise.

The problem is simply one of keep-

ing the bacilli out of the water-supply, and this can be accomplished only by proper sanitation. In this country the location of towns along watersheds is such that the sewage of one community is nonchalantly discharged into the water-supply of the other. Proper disinfection of the water is, therefore, the only means of guarding against typhoid epidemics.

Purification of Water.—A number of methods, all more or less efficient, have been introduced to purify water, either by or without filtration. One of the methods of purification without filtration consists in exposing the water to the air in small streams. This was proposed by Lind, more than a century ago. The water is passed through a sieve, or a perforated tin or wooden plate, then falling through the air in finely divided currents. Sulphuretted hydrogen, offensive organic vapors, and possibly dissolved organic matters are thus removed. This process has been used in Russia on a large scale.

Again, typhoid bacilli are all destroyed by boiling water acting on them for 10 minutes.

Potassium permanganate is sometimes used to purify water containing considerable organic matter. The permanganate rapidly oxidizes this matter. There is no certainty, however, that the germs of specific diseases are destroyed by this salt, in the proportion in which it could be used for water purification. A yellow tint is given to the water by the permanganate which is due to finely divided peroxide of manganese. This does no harm, but is unpleasant. Bromine has been used for a similar purpose, and is claimed to give good results. It may be neutralized by ammonium or other alkali.

In 1904, Moore and Kellerman, of the U. S. Bureau of Plant Industry, advised the use of copper sulphate, finding that in a ratio of 1:100,000 copper sulphate is an efficient germicide, destroying the colon and typhoid bacilli. It was also discovered that copper vessels are capable of purifying water through the colloidal copper. Later reports, however, showed that the claims of Kellerman and his fol-

lowers are greatly overdrawn. Aside from the fact that it would not be safe to introduce copper sulphate into the system for a long time, the germicidal action of copper has been found to be very uncertain.

Regarding the effect of copper and other metals on *B. coli*, it has been found that the organism disappears in the following number of days: Zinc, 10 days; iron, 15 days; tin, 41 days; aluminum, 41 days; copper, 43 days; lead, 97 days; and in another experiment: Zinc, 10 days; copper, 10 days; tin, 23 days; iron, 23 days; lead, 23 days; aluminum, 31 days.

Filtration.—Filtration has proven the most reliable means of removing both suspended matter and bacteria from polluted water. Filtration is practised on a small scale—domestic filters—and on a large scale. Of the domestic filters only those made of unglazed porcelain (the Pasteur filters) or infusorial earth (the Berkefeld filter) are to be relied upon. Their pores form tortuous channels in which the bacteria are retained. At length the filter is permeated with bacteria, which are pushed through, as it were, by the incoming armies. The filtering unit should, therefore, be frequently scrubbed and sterilized in the oven or by boiling at least once a month. All other domestic filters on the market are practically worthless, if not harmful because of the false security they give.

On a large scale, water may be purified by sedimentation, slow sand filtration, or the English method, and rapid sand filtration, or the American method, also known as mechanical filtration.

In sedimentation water is confined in reservoirs holding 30,000,000 to 50,000,000 gallons and allowed to become clarified by the particles of mud falling to the bottom. Incidentally, the bacteria are carried down and some oxidation of the organic matter takes place. Usually about 75 per cent. of purification takes place by this method. In St. Louis the water is treated with iron sulphate and lime before final sedimentation. The purification of the water is thus greatly enhanced.

Slow Sand Filtration.—This method was originally employed in London to remove from water the matter in suspen-

sion. Later, however, Frankland showed that the filters also remove most of the bacteria. Since 1890 the Massachusetts State Board of Health has been conducting extensive experiments on slow sand filtration, and placed it on a solid scientific basis. The principle underlying it is a biological one.

The forces are the same as operate naturally when a foul surface pool percolates slowly through the ground and crops out in the form of a pure, sparkling spring. The upper layers of the ground swarm with various bacteria which live on dead organic matter. In a word, the organic substances of the water are attacked from all sides and converted into harmless mineral substances, the latter to be taken up by the plants as food. If any pathogenic bacteria happen to be present they find a strange, uncongenial environment. The relatively low temperature chills them; then, being parasitic in nature, they cannot prepare food for themselves, while the food that they find is rapidly consumed by their competitors, which are in greatly predominating numbers. Thus, the pathogenic organisms soon perish.

Similar conditions prevail in the slow sand filter. Here we have a bed of fine sand about three feet thick, through which the water percolates at a rate of 3,000,000 to 4,000,000 gallons per acre per day. Suspended matter in the water passing through is deposited between the sand grains, in the upper inch or two. The infusoria, algæ, and bacteria in the water are now entangled and form a slimy film about the sand grains, on the surface of the bed. The various bacteria at once commence to work, each species performing its particular function and making a struggle for existence. The result of this is the transformation of the complex organic molecules into simple inorganic compounds. Pathogenic bacteria are enmeshed in this film and soon perish in the unfavorable environment. In time the upper mud-film becomes more compact, until but little water passes through, viz., about once in three weeks. When this occurs, the filter is drained, the upper layer of the beds removed, and filtration resumed.

Sand filters have been installed in almost all the large cities of Europe, and wherever installed have reduced typhoid mortality to a very small percentage.

In this country the first slow sand filter was built by Kirkwood, in Poughkeepsie, N. Y., in 1877. The first filter, however, contributing to our knowledge of the subject, and which has served as a model for other plants, is the slow sand filter constructed in Lawrence, Mass., in 1893. This filter has been in operation ever since, giving excellent results, both as to improvement of the polluted Merrimac water and reduction of typhoid mortality.

Slow sand filters exist in a number of American cities, the most notable of which is Albany, where a covered slow sand filter was constructed by Mr. Hazen in 1899. The improvement in the mortality from typhoid fever and diarrheal diseases has been very marked.

Slow sand filters have also been constructed in Providence, R. I.; Washington, D. C.; Hudson, N. Y.; Mount Vernon, N. Y.; Far Rockaway, L. I.; Ilion, N. Y.; Yonkers, N. Y.; Somersworth, N. H.; Ashland, Wis.; Superior, Wis.; St. Johnsbury, Vt.; Milford, Mass.; Nantucket, Mass.; Nyack, N. Y.; Lambertville, N. J.; Salem, N. J.; Rock Island, Ill.; Grand Forks, N. D.; and are in the course of construction in Philadelphia, Pa.; Pittsburgh, Pa.; Wilmington, Del., and other cities. Experience thus far gained warrants the general proposition that properly filtered water is fully equal in its hygienic purity to a pure natural supply.

Mechanical Filters.—In the mechanical, rapid or American system of filtration, the water is conducted through sand as in slow sand filters. Foreign substances are retained mechanically, but this retention is aided by the application of chemicals. Through these, and due to the absence of biological action, the filters can be operated at much higher rates than slow sand filters. Their usual rate is 125,000,000 gallons per acre per day, while slow sand filters are operated at about 3,000,000 gallons. A more rapid passage through a slow sand filter would be liable to wash the bacteria from the sand grains about which they live, and so interfere with success.

The chemicals usually used in mechanical filters are sulphate of aluminum or sulphate of iron and lime. The former, when used, is led into the water before it enters the filters and there combines with the lime naturally present in nearly all waters to form hydrate of aluminum and sulphate of calcium. The former, insoluble, agglomerates, by means of its stickiness, the bacteria and other particles into masses such as cannot pass between the sand grains. When sulphate of iron and lime are used, the action is exactly similar, but hydrate of iron is formed instead. Owing to the more rapid operation, the dirt accumulates on the surface faster than it does in a slow sand plant, necessitating more frequent cleansing.

In mechanical plants the cleansing of the sand is accomplished by turning a current of filtered water upward through the sand, and at the same time agitating the whole bed of sand by means of rakes driven mechanically or by compressed air forced through the sand from below. All foreign matter is thus carried to the top of the filter, whence it is conducted to the sewer by pipes. The cleansing operation usually takes about ten minutes, and its frequency depends entirely upon the character of the water treated,—ordinarily about every twenty-four hours, 2 to 5 per cent. of the filtered water being required for cleaning purposes.

Skillfully constructed and operated, these filters are equal in efficiency to a slow sand filter; but, on the other hand, the mechanism of operation is much more complex, the possibility of some unlooked-for derangement greater, with consequent imperfect purification of the water.

Chlorine Gas.—Compressed chlorine has been largely employed in purifying water, either alone or in combination with filtration. The method is remarkably efficient, and when carefully used is in no way objectionable.

Flies in Typhoid.—The rôle of the domestic fly as a carrier of typhoid bacilli was definitely established during the Spanish-American and Boer Wars. A special commission found

that flies were responsible for a severe epidemic among soldiers in the Southern camps in Florida. Flies were observed to swarm over infected fecal matter in the pits, and then visit and feed on the food prepared for the soldiers in the mess-tents. When lime had been recently sprinkled over the contents of the pits, flies with their feet whitened with the lime were seen walking over food. Typhoid gradually disappeared in the fall of 1898 with the approach of cold weather and the consequent disabling of the fly.

This circumstantial evidence was substantiated by Firth and Horrocks in England; Hamilton, of Chicago, and Ficker, of Leipzig. The latter caught flies in a house at Leipzig, where 8 cases of typhoid had occurred. The flies were kept in 10-liter flasks, into which sugar, strips of blotting-paper and typhoid bacilli were introduced. The typhoid culture was spread on the inside of the blotting-paper. After 18 to 24 hours the flies were transferred to clean flasks, and this was repeated every 2 or 3 days for over 4 weeks. They were at last killed with ether and crushed, and the remains transferred on gelatin. A growth of typhoid bacilli was obtained from flies crushed 23 days after exposure to infection.

"From their disease-carrying potentials the mouth and legs and intestines of flies are important parts. The six legs are bristly and strong, each leg has two claws, and between the claws there are soft, sticky pads called *pulvilli*, with which the fly clings to seemingly impossible slippery surfaces: for there are hairs around the pad which secrete a sticky fluid. The mouth consists of a proboscis which ends in two flabby pads, which can be protruded and applied to the food. There are no teeth, but each mouth-pad has some

hard ridge which can be used as rasps or saws for breaking up small hard objects in the food; the flies' saliva does the rest of the mastication. The saliva is poured out on to the sugar and a thick paste is made. The mouth-pads are there applied, and the paste is sucked up and swallowed. Then the fly moves on and repeats the process. Some of the paste adheres to the pads and the proboscis, and the fly then uses her front legs to clean her face. In consequence her legs become covered with food too and with any germs it may contain, and she uses the hind legs to clean the front ones, and then they are all covered with food and its germs. But the fly likes to live in the midst of plenty, and the more filthy the food she has sticking to her mouth and legs, the better she enjoys it. The germs like it too, for the fly never has a bath. It is a grand dirty life for all concerned.

"It can be readily understood how disease germs live and multiply on these sticky surfaces. . . . There is no doubt that germs are swallowed by flies, and can and do multiply within the bowels of the insects. The fly's internal digestive apparatus is very simple. There is a throat winding up the proboscis, a long gullet leading to the stomach and intestines. There is also a crop connected with the gullet by a long tube: this crop is a large distensible bag where food is stored until hunger requires its digestion. According to Dr. Graham Smith, house-flies, after a meal, frequently regurgitate drops of fluid from their mouth, and these drops are responsible for the larger marks on the lump-sugar or on the window-pane. The smaller marks are those of excretion, fully digested by the fly and passed from the intestine, which contains an almost pure nidus for bacteria. Thus are fly-specks made. Everything seems to have been disposed by a provident nature for the germination of germs on and in house-flies. These insects can harbor and foster typhoid and cholera bacilli on their feet, on their mouths and proboscides."—E. H. Ross ("The Reduction of the Domestic Flies").

PROPHYLAXIS.—"The primary responsibility for the spread of the

disease rests, in great measure, with the physician in charge of the case. It is incumbent on him to see that no avenue by which the bacilli can escape into the external world is left unguarded. All germs excreted by the patient should be at once thoroughly destroyed. For this purpose no half measures should be tolerated. Disinfectants (true germicides, not antiseptics) should be employed, and in strength sufficient to destroy with certainty the germs in the material on which they act. . . . The disinfection should be carried on day by day throughout the course of the disease. Disinfection after the termination of the disease is of minor importance. Disinfection of the air is also relatively unimportant. The germs are borne by the solid and liquid excretions, and the hands, clothing and food soiled with them. Direct contagion, although possible, is rare.

"To disinfect the urine the best solutions are: phenol (carbolic acid) 1:20, in an amount equal to that of the urine, and bichloride of mercury 1:1000 in an amount $\frac{1}{15}$ that of fluid to be sterilized. These mixtures with the urine should stand at least 2 hours.

"In case there is demonstrable *bacilluria*, hexamethylenamine may be given to cause disappearance of the bacilli from the urine, but under no circumstances should its administration permit the disinfection of the urine to be neglected.

"To disinfect stools, phenol is most useful. It is cheap and efficient, if used in strong solutions. The stool should be mixed with about twice its volume of 1:20 phenol solution and allowed to stand for several hours.

"Disinfection of the bath-water after use is best accomplished, according to E. Babucke (*Centralbl. f. Bakteriologie*, xxvii, 800, 1900), by the use of chloride of lime; 250 Gm. ($\frac{1}{2}$ pound) of chloride of lime will render the ordinary bath of 200 liters (quarts) sterile in $\frac{1}{2}$ hour.

"In cases in which sponging is practised, the amount of water used would be small, and would require correspondingly a small amount of the disinfectant.

"If there be any expectoration, the sputum should receive the same care as in tuberculosis. It is best to collect it in small cloths, which may be burned.

"All the linen leaving the patient's bed or person should be soaked for 2 hours in 1:20 phenol solution, and then sent to the laundry, where it should be boiled. It is recommended to boil the dishes from which the patient has eaten before they are taken from the room. If this precaution is impracticable, they should at least be treated in some other way, as by wrapping in paper so that they cannot convey infection. They should afterward be boiled or washed separately from the other dishes.

"It is also recommended that the nurse should wear a rubber apron when bathing or handling otherwise a typhoid patient, and should also wear rubber gloves or else wash the hands thoroughly in a 1:1000 bichloride solution after she has finished, or she should wash thoroughly in soap and water, followed by 70 per cent. alcohol.

"Great care should be taken to prevent access of flies to typhoid excreta and to food supplies. The room of the typhoid patient should be kept

thoroughly screened in fly season. The nurse or other attendants should be taught to regard every specimen of urine as a pure culture of typhoid bacilli, and should carefully avoid the spilling or scattering of drops of urine.

"The danger from contamination with the urine should be impressed on the convalescent patient, who should be encouraged to continue the use of hexamethylenamine and to report to the physician for examination of the excreta until it is satisfactorily shown that no more typhoid bacilli are being passed by the patient, either in the urine or feces." (*Jour. Amer. Med. Assoc.*)

Typhoid fever may also be communicated by drinking contaminated milk, bacilli gaining access to the water used in washing the cans or in adulterating the milk. Direct contamination from the hands of a "typhoid carrier" is also possible. Once in the milk, the typhoid bacilli find a most favorable medium for rapid development. A milk epidemic can usually be traced by following out the cases on a suspected milk route.

Other foods which may carry the typhoid bacilli are oysters and green vegetables. Repeated epidemics have been caused by oysters kept in sewage-polluted beds. The custom of fattening oysters in fresh water, often polluted, is pernicious.

Lettuce, celery, radishes, and other truck-farm products may carry typhoid bacilli as a result of the fertilization of small truck patches by human excreta. These vegetables, consumed raw, often after a perfunctory washing, constitute a serious menace.

Ice may be the source of infection

if manufactured from polluted water, or obtained from a polluted stream. Use of ice from an unknown source in drinking-water is inadvisable.

Direct infection from sick to well is not uncommon when the attendant is careless in handling the patient or the soiled linen. This mode of transmission, however, is not a usual source of epidemics.

Typhoid Vaccination.—This is the most important form of prophylaxis.

The vaccine ("typhoid prophylactic") is a suspension of dead bacilli in salt solution, with 0.25 per cent. of tricresol added as a measure of safety. The vaccine is accurately standardized by counting the bacilli; 500 millions are given as the first dose and 1000 millions each for the second and third, 10 to 20 days later. The skin of the upper arm is sterilized with iodine and the vaccine is injected subcutaneously. There is a local reaction consisting of a small red and tender area lasting about 48 hours. The general reaction, when present, gives rise to a headache and malaise, and sometimes to fever, chills, and occasionally nausea, vomiting or diarrhea. Severe reactions do not occur in more than 1 to 3 persons per 1000. They all pass off quickly and leave no trace. Only the healthy should be vaccinated.

In 1911 the use of antityphoid vaccine was made compulsory for all men in the army under 45 years of age. As a result, both the morbidity and mortality from typhoid fever were practically eliminated. During the European war, vaccination against typhoid having been rigidly enforced in the main contending armies, the incidence of the diseases was very slight. More trouble was

experienced from paratyphoid infections, until systematic vaccination against these was likewise enforced. As a rule, a vaccine protecting against both the typhoid and the A and B paratyphoid organisms is now generally employed. The initial dose of 0.5 c.c. contains, in addition to 500 million *B. typhosus*, half that number of each of the paratyphoid germs. Double this dose is, as a rule, subsequently injected twice at eight to sixteen day intervals.

PARATYPHOID FEVER.—This is produced by 1 of 2 organisms, viz., either the paratyphoid bacillus "A" or "B."

Symptoms and Diagnosis.—Willcox divided the cases into 3 groups: Those with sudden onset and characteristic symptoms; mild cases, often classed as pyrexia of unknown origin; and severe toxic cases closely resembling true typhoid.

As described by Torrens and Whittington, there are 2 distinct types of onset: 60 per cent. of the patients feel increasingly ill for a variable number of days (the average being 4) before they seek medical advice. The other 40 per cent. are overcome in a few hours or collapse while at their duties. The symptoms noted, in the order of frequency, are: headache, diarrhea, abdominal pain, aching pains in the limbs, shivering, extreme general weakness, backache, and epistaxis. Other less common but not rare symptoms are cough, nausea, and vomiting, loss of appetite, dizziness, deafness and constipation.

Usually a condition described as "lethargic," "heavy," "drowsy," "inert," etc., is found, except in the mild cases; the temperature in the second week varies from 99.2° to 102.4° F. (37.3° to 39.0° C.) and produces the "spiky" temperature chart which is characteristic, a steady temperature being observed in only 5 per cent. of cases; the pulse is low in proportion to the temperature, even more so than in true typhoid, e.g., a pulse of 70 when the temperature is 102.5° F. (39.1° C.); the blood-pressure is usually from 80 to 100 mm. Hg., systolic. Spots, which occur in

75 per cent. of all cases, appear in crops which last for 3 or 4 days, are first seen about the 7th to the 10th day, but in some instances as late as the 35th day. The tongue is practically as in typhoid, and the abdomen offers no changes except in about 30 per cent. in which there is some distention. The spleen is enlarged to palpation or percussion in 60 per cent. The only change in the chest is an occasional bronchitis.

Complications.—The important complications are bronchitis in about 4 per cent., meteorism rarely, hemorrhage (more common in paratyphoid B) in about 5 per cent., perforation in 3 per cent., and thrombosis of the femoral vein in 3 per cent. Other complications and sequelæ are: relapse, recrudescences of fever, pleurisy, empyema, abscess of lung, pericarditis with effusion, tachycardia, laryngitis, tonsillitis, otitis media, parotitis, suppurative orchitis, neuritis, meningismus, mental weakness in convalescence, periostitis, pyelitis, cholecystitis, abscess of spleen, and peritonitis without perforation. The mortality in paratyphoid B was found by Torrens and Whittington to be a little over 4 per cent.; of paratyphoid A, less than 1 per cent.

Diagnosis.—A positive diagnosis can be made only by recovering the specific bacillus from the blood, feces, or urine, or, by discovering evidence in the blood that the patient has acquired, or is acquiring, an immunity to a specific infection (agglutination reaction). According to Carles and Marcland, a slow pulse, not above 80, is of some significance in the distinction of paratyphoid from typhoid.

Treatment.—This is similar to that of typhoid fever. EDITORS.

TYPHOID FEVER IN INFANCY.—According to Dr. Griffith the onset in infants is, as a rule, decidedly shorter than later—roughly, 3 to 4 days before the fully developed attack is reached, this being marked by the appearance of roseola or by the fever reaching its height. In about one-third of the cases the onset may be called sudden, the tempera-

ture being often at its height when medical aid is first invoked. The step-like rise of the adult type is rare. Vomiting is a frequent early symptom, at times very troublesome; diarrhea is oftener observed than later in life, and is probably more frequent than constipation. Cough is not a very common early symptom, nor is abdominal distention. Loss of appetite is frequent; nose-bleed is uncommon; there is not much prostration. Convulsions are rare, and an onset simulating meningitis is very unusual.

In the developed attack vomiting is comparatively frequent; diarrhea continues to be oftener seen than constipation; coating of the tongue is common, but dryness and fissuring are very exceptional; there is not much anorexia; distention is frequent, but not troublesome. Of respiratory symptoms, cough is perhaps oftenest seen, but less common than in adults. Epistaxis does not often occur. The pulse maintains its strength except in the severer cases. Nervous symptoms of the nature of depression are not at all a prominent feature in infancy; and it is only in the severe cases that there is marked prostration. On the other hand, the manifestations of nervous excitation are oftener seen than later, viz., irritability, fretfulness, and crying.

Roseola is perhaps as frequently seen in infancy as later, and seemingly tends to appear earlier in the attack, oftenest somewhere from the fourth to the sixth day; and the same is true of splenic enlargement. Absence of a leucocytosis is as characteristic as in adults; also the Widal reaction.

The temperature is not character-

istic, and many variations are witnessed. It may continue elevated from 103° to 105° F. (39.4° to 40.5° C.), little influenced by bathing, for a week or more; then becoming more irregular. In many other cases it is very irregular throughout. The final fall is often rapid, almost by crisis. It is always more rapid than in adults, lasting only three to four days, and being without the evening rise and morning fall. The total course is three weeks or less; in many, not over two weeks.

TYPHOID FEVER IN EARLY CHILDHOOD.—The onset is not so sudden as in very many cases in infancy, yet often abrupt. The attack may be ushered in by convulsions, or may exhibit for a few days confusing meningitic symptoms. Oftener, however, the onset is remarkably insidious, nothing of importance being suspected until, perhaps, the roseola and enlarged spleen are found. It is thus frequently difficult to determine when the attack commenced.

In the eruptive stage there is generally an absence of the evidences of the typhoid state so common in adults. Nervous symptoms are little marked; at most, as a rule, some apathy, with, perhaps, slight nocturnal delirium. Diarrhea is less frequent than in either infancy or later childhood. Dryness of the tongue is rare. Vomiting is more common than in adults. Abdominal distention is seldom troublesome. The temperature is more suggestive of typhoid fever than in infancy, but the third stage is always short and without any remittent character. The total duration is two to three weeks. Complications are infrequent. To all this there are, of course, numerous exceptions.

TYPHOID FEVER IN LATER CHILDHOOD.—After the age of 6 years, the disease gradually approaches the adult type, especially after the age of 10 years. Diarrhea is now often troublesome, due to greater intestinal ulceration. Hemorrhage and perforation are more liable to occur. The typhoid state is more likely, yet not to the extent seen in adult life, and only in severe cases. The course is longer than before, frequently equalling the ordinary 4 weeks of the adult, and the temperature of the third stage is often more remittent.

The *pathology* is the same as in adults, except that ulceration of the ileum is less common. Splenic enlargement is prominent, and should be sought where the diagnosis is doubtful.

The *treatment*, as in adults, is symptomatic, and depends largely on the condition of the patient. Careful nursing and attention to diet are of far greater importance than drugs.

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TYPHUS FEVER (*Typhus Gravior; Typhus Exanthematicus; Camp Fever; Ship Fever; Jail Fever; Spotted Fever; Putrid Fever.*)—**DEFINITION.**—An acute infectious febrile disease, commencing abruptly, continuous in type, reaching its crisis in about two weeks, accompanied by maculated or petechial spots on the surface and prominent nervous symptoms.

SYMPTOMS.—The period of incubation lasts between seven and fourteen days. The patient then abruptly develops pains in the head, back, and limbs, with a chill or alternations of heat and cold, soon followed by decided fever and marked prostration. Epistaxis has been noted. The face becomes markedly flushed, the skin dry and red, and the

vessels of the conjunctiva injected. The tongue usually shows a white coat, the mouth is dry, the pulse frequent and moderately full, the bowels inactive, and the urine dark and scanty. There is much restlessness, or mental dullness, with indications of delirium. The spleen is usually early enlarged.

The symptoms reach their climax in five to seven days. The temperature advances with but little or no morning remissions from 103° F. on the first day to 104° or 106° F. on the fifth or sixth day, after which it recedes one or two degrees each morning, rising again in the afternoon and evening. During the same period the tongue becomes more thickly covered with a dry, brown coat; sordes appears; the pulse often reaches 120 to 130 per minute, and is less full. The breathing is accelerated and shallow; a dry, congested condition of the respiratory membranes is generally present, and later more or less hypostatic lung engorgement.

In most cases a rash appears between the third and fifth days, first over the abdomen and upper chest, then, in two or three days, over the back and extremities. The face, though red and swollen, seldom exhibits the eruption. Many of the spots are dull-red and appear as though beneath the cuticle. Others are more papular, and in severe cases they undergo hemorrhagic transformation or begin as petechiæ, presenting later a dirty, bluish color, and only partially disappearing on pressure. In mild cases the eruption is generally slight, or even absent. A distinct leucocytosis generally exists.

In a few severe cases vomiting and diarrhea occur early in the disease, but, as a rule, the stomach and bowels are inactive and the abdomen free from gurgling and tympanites. The delirium is frequently of the alert, violent type, but may pass into coma vigil. In the most severe cases the patient becomes early and persistently delirious, the conjunctival vessels injected, and the pupils small. A copious petechial or hemorrhagic eruption appears, the temperature rises to 105.8° or 107.6° F. (41° to 41.9° C.), and the pulse to 140 per minute and weak. The urine is scanty and albuminous. Tremor and subsultus

tendinum are marked. Such cases generally end fatally in the first week. In a larger number of fatal cases these symptoms develop more slowly and do not end in death until the end of the second week or the first half of the third. When the patient is progressing toward recovery there is dullness and light delirium, from which the patient can be more readily roused during the morning hours. Such cases may reach a crisis about the end of the second week, when the patient falls into a more natural sleep, awakening later with his mind clear, skin moist, and urine free. After one or two bowel evacuations, rapid defervescence follows, and in two or three days convalescence is fully established, though accompanied by great prostration. The skin lesions, except the petechiæ, pass off before the defervescence. Exceptional cases occur during almost every epidemic, featured by active diarrhea and vomiting. Again, cases are occasionally met with in which laxatives are required throughout the course of the disease. Such cases generally exhibit much delirium or stupor and subsultus.

Brill's Disease.—A mild form of typhus fever has been shown by Brill and others to be rather common in the eastern United States, having probably been mistaken previously for typhoid fever, which, in some ways, it resembles. Anderson and Goldberger showed, in 1912, that this mild typhus was identical with the typhus ("tamarillo") frequently met with in Mexico. The condition should manifestly be constantly borne in mind by the physician in the presence of doubtful typhoid.

DIAGNOSIS.—The diseases with which typhus has been oftenest confounded are typhoid, cerebrospinal meningitis, malignant measles, septicemia, and some cases of acute miliary tuberculosis. The chief diagnostic features in the differentiation from typhoid fever are the short prodromic stage in typhus; the more marked chill; the more prompt fever, without morning remissions during the first week; the more severe pains in the first stage; the greater delirium, stupor, and subsultus, with little or no diarrhea or tympanites; and especially the papular or petechial eruption, which appears earlier in a single crop, does not fade completely

on pressure, and is common on the extremities. An eruption of dark-red or purplish macules may, however, appear in advance of, or be interspersed with, the more papular clusters. The Widal reaction and blood-cultures are important as differential laboratory tests. From measles typhus is distinguished by the appearance of the eruption on the abdomen and chest first instead of the face and neck; the less prominent coryza and cough; the absence of Koplik's spots, and the less severe course (except in malignant measles). The usual drop in temperature coincident with the measles eruption does not occur in typhus. **Cerebrospinal fever** is distinguished by the more intense nervous phenomena, with somewhat less prostration; the more common vomiting; the usually lower fever; Kernig's sign; the positive lumbar puncture, and, perchance, the existence of an epidemic of this disease at the time. The eruption in cerebrospinal meningitis is macular and less constant than in typhus. Differentiation of typhus from **septicemia** may be impossible until after a few days' observation.

Brill's disease is to be differentiated from **typhoid** by the short incubation (4 or 5 days); the chill; the reaching of the fastigium in three days; the relatively slight temperature remissions; the deferrescence not exceeding 60 hours in duration; the maculopapular eruption, with periphery indistinct and irregular; its not infrequent appearance on the limbs, and occasionally on the palms and soles, as a single crop, with petechiae occasionally, and sometimes confluence; the early apathy and prostration; labial herpes in 6 per cent. of cases; constipation almost invariable; no bowel hemorrhage; headache intense and persistent; Widal and blood-cultures always negative; absence of relapse, and convalescence speedy.

ETIOLOGY AND PATHOLOGY.—

Typhus fever prevails chiefly among those living in overcrowded, uncleanly, and ill-ventilated houses, camps, prisons, and almshouses, and with insufficient food. The formerly prevalent "ship typhus" of sailing vessels is now practically unknown, owing to the more rapid and sanitary emigrant passenger traffic in late decades established. The disease in its

severe, typical form is rare in the United States, occurring chiefly in certain districts bordering on the Baltic Sea, in Hungary and Turkey, in southern Italy, in northern Africa, and to some extent in the British Isles. It is largely a cold-weather disease. No age is exempt, though children under 6 years seem relatively insusceptible, and about two-thirds of the cases occur between the ages of 15 and 40. Numerous physicians and nurses have been victims.

That the virus of typhus is transmitted by the body louse has been abundantly proved by Nicolle, Ricketts, and others. The head louse is probably also a carrier (Anderson and Goldberger), but not the crab louse. The disease is apparently not transmitted by fomites, nor by direct contact unless such contact permits of exchange of body lice. Various organisms have been described as the cause of the disease. Evidence has been presented that the *Bacillus typhi exanthematici* described by Plotz, of New York, in 1914, and studied also by Baehr, Olitsky, Denzer, and Flusk, is the actual etiological factor. It is a gram-positive, anaërobic bacillus, was obtained from the blood of typhus patients, recovered from animals, and yielded agglutination and complement-fixation reactions with blood taken after the crisis. According to Friedberger, the *Bacillus proteus* X 19 of Weil-Felix is the pathogenic agent. Craig and Fairley (1918) deemed the agglutination test with this organism (Weil-Felix reaction) an invaluable diagnostic aid.

The intestinal follicles in typhus may be swollen, but Peyer's patches and the mesenteric glands show no change. The early splenic enlargement is likely to have subsided after the middle of the second week.

PROGNOSIS.—Murchison, in 18,592 cases of typhus, collected from the leading hospitals of London, Edinburgh, Glasgow, and Paris, found an average mortality of 18.78 per cent. During severe epidemics the mortality in European hospitals has been from 20 to 25 per cent., and in unsanitary surroundings it may rise to 50 per cent. In mild epidemics it may not exceed 10 per cent. In the mild American cases described by Brill it is

less than 1 per cent. (one death among Brill's 255 cases). Crowding, overexertion, alcoholism, a petechial eruption, hyperpyrexia, a soft or irregular pulse, and pulmonary or renal complications are unfavorable prognostic features. In the aged and in small children the mortality is high; in older children, low.

PROPHYLAXIS.—This consists essentially in the destruction of lice that may have become infected with the virus, and in avoidance of all contact with the patient or his effects until this has been accomplished. The patient's clothing should be sterilized or burned up, his hair clipped, and the head washed with 4 per cent. phenol solution. Those living with him should be similarly dealt with, and the premises thoroughly cleaned—preferably fumigated with sulphur (not formaldehyde), using 2 pounds of sulphur for every 1000 cubic feet of space, properly sealing the room, and not opening it for at least two hours. General prophylaxis during an epidemic consists in isolation of the patients in tents or temporary barracks, periodic inspection of crowded, unsanitary premises, and a general campaign against lice. **Prophylactic vaccination** has seemed effectual in tests made in Serbia, Russia, and Mexico (Plotz).

TREATMENT.—Absolute rest in bed and pure, fresh air are essential. A liquid diet should be given, comprising milk and its modifications, albumin-water, broths, and even eggs. Milk containing 1 ounce (30 c.c.) of fresh lime-water in every 6 ounces (180 c.c.) may be alternated at two-hour intervals with a broth. An attempt should be made by giving water freely at regular intervals, to augment the output of urine to several liters (quarts) a day. A mixture of equal parts of liquor ammonii acetatis and spirit of nitrous ether may be given to promote diaphoresis

as well as diuresis, and calomel administered to evacuate the bowel, to be followed by saline purgatives in the subsequent course of the disease. Warm enemas, containing 2 drams (8 Gm.) of sodium chloride, are useful. Irrigations of the nose and mouth with some mild, alkaline, antiseptic solution are indicated, as in typhoid fever.

For the fever, hydrotherapy, preferably in the form of the cold tub-bath, as in typhoid fever, should be instituted; in the mild cases, cool sponging or packs may suffice. For the nervous symptoms, an ice-bag or cold cloth should be kept in contact with the head, and where there is pronounced delirium or headache, or sleeplessness, Dover's powder, 10 grains (0.6 Gm.), with bromides, 20 grains (1.2 Gm.), may be given, or, better, in severe cases, morphine subcutaneously.

When evidences of circulatory weakening appear, not uncommonly accompanied by shallow respiration, impaired resonance over the lung bases, and increasing stupor and muttering delirium, stimulants such as strychnine, gr. $\frac{1}{40}$ to $\frac{1}{20}$ (0.0015 to 0.003 Gm.) hypodermically, caffeine sodiobenzoate, 7½ grains (0.5 Gm.) hypodermically, camphor oil injections, and digitalin, gr. $\frac{1}{4}$ (0.012 Gm.) hypodermically, are indicated. To reduce the chances of serious hypostatic congestion the patient should be frequently rolled from one side to the other. Laryngeal edema may require tracheotomy. Saline infusion should be available for immediate execution at any time after the eruptive stage.

During convalescence, which is usually rapid, nutritious but easily digested food should be supplied. The patient should be kept very quiet for some days after defervescence, a depressive circulatory reaction, as a rule, following the cessation of fever.

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ULCERS AND VARICOSE ULCERS. See VASCULAR SYSTEM, SURGICAL DISEASES OF.

UREMIA.—Uremia is a term applied to a group of symptoms at-

tributed to the retention in the blood of substances which should normally have been excreted in the urine. It is met with in Bright's and other disease of the kidneys (gouty kidney,

scarlatinal nephritis, cancer, tubercle, suppuration, etc.), in diseases such as cholera, typhus, and yellow fever; and also in cases of anuria, obstructive or non-obstructive, pregnancy, and parturition.

SYMPTOMS.—Two clinical types of uremia may be distinguished, the acute and chronic:—

Acute uremia includes all the cases in which the symptoms develop suddenly. It occurs not only in the different forms of nephritis, but also in angina pectoris, pulmonary emphysema, chronic endarteritis, and other disorders, and seldom lasts more than a few days. Two main forms are commonly recognized: the comatose and the convulsive.

In the *acute comatose form*, coma develops rapidly after the appearance of headache, vertigo, more or less disturbance of vision, vomiting, somnolence, general malaise, often with a positive Babinski reflex preceded by a preliminary depression of all reflexes; or it may be unattended by premonitory symptoms. In some cases, epileptoid convulsions alternate with coma. The face is usually pale; the pupils react slowly to light and are dilated or unaltered; in other cases we may observe a red spot on the cheek, injected conjunctivæ, and contracted pupils. There is a peculiar, stertorous breathing—not the deep snoring observed in hemorrhagic apoplexy, but a sharper, more hissing sound, produced by the rush of expired air on the hard palate or teeth. Anuria is frequent and may occur as initial symptom. Amaurosis, which disappears as suddenly as it sets in, may also occur; deafness likewise, though rarely. Indicanuria is usually present. Death may occur

in a few hours from a rapid deepening of the coma; or the patient may recover and continue permanently free from the symptoms. Again, uremia may recur, sooner or later, and death follow.

The *acute convulsive form* may be marked by symptoms almost exactly simulating those of epilepsy; there may be no loss of consciousness; or the spasms may be confined to certain groups of muscles, and thus simulate tetanus. The attack is sudden, with or without warning. It may be a single attack, or a rapid succession of them may occur: 5 or 6, or even more, in the course of twelve hours. These attacks may prove rapidly fatal, either during the paroxysm or in the coma which succeeds it; or they may be recovered from. Convulsions may occur in any of the various forms of Bright's disease, but most frequently in the cirrhotic and inflammatory varieties; they may, indeed, be the first warning of the existence of cirrhosis of the kidney.

Both these acute types may be so merged as to render the identification of either impossible. Hence, the so-called "*mixed form*" of some authors.

Chronic uremia develops gradually, as a rule, and may not be recognized at once, although the pathognomonic listlessness and indifference of manner in cases of Bright's disease becomes somewhat more marked. The movements become slower, and speech is somewhat indistinct. Dimness of vision, tinnitus aurium, an uneasy feeling in the head, or, perhaps, violent and persistent headache may be present. Asthmatic attacks—*uremic asthma*—most frequent at night may occur. There is, as a rule, marked pallor. The blood-pres-

sure is generally high, 200 mm. or more, and the heart is often hypertrophied. The symptoms occasionally improve or disappear, but they uniformly recur, and gradually become more intense.

The drowsiness may pass into stupor. When the patient is roused to speak, articulation is at first thick and indistinct, but, later, he cannot be made to respond; stupor deepens into coma; the breathing assumes the characteristic stertor before mentioned; Cheyne-Stokes breathing may occur independently of the comatose state. Stomatitis, with fetor of the breath, redness, swelling and tenderness of the oral mucosa, hiccough, vomiting, and diarrhea are common.

Exceptionally, the patients may suffer from a noisy delirium, in which prolonged howling alternates with muttering or with paroxysms of excitement, or delusional insanity (*folie Brightique*). There may be low prolonged muttering, with a repetition of the same word or phrase. Subsultus tendinum and twitching of the facial muscles are commonly seen throughout. Cramps in the muscles, especially in those of the calves, are common. Convulsions, diarrhea, and vomiting are frequently present. Epistaxis may occur, but is rare. Pruritus is usually complained of, and is thought to be due to irritation of the cutaneous nerves by the urea excreted adventitiously by the sweat-glands. Indeed, crystals of pure urea may cover the body with a frost-like but odorless coating. The action of the heart and pulse is strong at first, then feeble. The temperature tends to be subnormal excepting during convulsions, but may become considerably

elevated when death is approaching. The patients pass into a condition of great prostration, with alternating delirium and stupor ending in fatal coma. Death may occur, as an exception, in the early stage of the inflammatory form. Chronic uremia may continue many weeks.

DIAGNOSIS.—Acute comatose uremia may closely resemble *cerebral apoplexy* with loss of consciousness, but may be distinguished from it by the absence of unilateral paralysis, the character of the breathing, pulse, and heart-action, and the urine.

Acute convulsive uremia may resemble *epilepsy*, but it usually lacks the initial cry, the death-like pallor, the predominance of unilateral convulsions, the inturning of the thumbs upon the palms, and the loss of reflex irritability. The urine, after an epileptic seizure, may reveal the presence of albumin and a diminution of urea, but it soon returns to a normal condition; in uremia it is always distinctly albuminous. The condition of the pupils and the examination of the urine will distinguish this condition from *poisoning by opium or belladonna*.

Chronic uremia, when fairly established, is usually recognized without difficulty. An examination of the urine furnishes the most valuable evidence. Chronic uremia may sometimes resemble *meningitis*, from which it may be differentiated by the history of the illness, the condition of the urine, the temperature, breathing, and weak pulse and heart action. Certain cases develop gradually and pass into a typical *typhoid state*; such are met most frequently at or after middle life and in connection with chronic interstitial nephritis.

Renal insufficiency should be determined by the *phthalein test* and others given in vol. VI, p. 203.

The writers recognize 3 types of so-called "uremia." The first, featured by convulsions, is merely a chloridemia, and occurs mostly in the young; the second, true uremia (azotemia), occurs at all ages, and the third, pseudouremia, after 40. Recovery is the rule in the first type; death is inevitable in true uremia, while pseudouremia permits of protracted survival. Treatment of the first type requires restriction of salt and water; of the second, restriction of protein food and salt, with plenty of water; of the third, some restriction of fluids, with rest and eventually tonics and heart stimulants. The first type is essentially mechanical, from retention of salt and water; in the second, toxic, urea and indican being the main toxic substances. In the third, or arteriosclerotic type, the symptoms resemble true uremia, but are due merely to deranged circulation. Blood indican reveals true uremia. Heim and Tchernkoff (Rev. méd. de la Suisse rom., Jan., 1918).

ETIOLOGY.—That uremia is due to the retention of excrementitious products is undoubted, but the nature of these products is unknown. Herter has shown that it could not be urea, though it is in marked excess in the blood. Strauss found the ammonia and nitrogen content of the blood greatly increased, notwithstanding the marked hydremia, the brain and kidneys being also edematous—a fact believed by some to account for the symptoms. A fall of the CO₂ tension below normal causes acidosis, according to Straub and Schlayer. Croftan had previously urged acidosis of metabolic origin as the most probable pathogenic agent. Cerebral anemia is thought by some to explain the symptoms.

PROGNOSIS.—The occurrence of uremia is always grave. When, however, uremic convulsions are due to acute disease, the prognosis is more hopeful, as the conditions leading up to them are often amenable to treatment. Puerperal cases are very frequently recovered from, as the combination of circumstances to which they owe their origin is of short duration. The chronic form of uremia is hopeless, though life may, by judicious care, be prolonged.

Experiments showed that the thyroid has unquestionably some influence on the clinical picture of uremia, either by neutralization of toxins or by stimulating the adrenals. It has a toxin-destroying function. Rémond and Minvielle (Bull. de l'Acad. de méd., Mar. 6, 1917).

TREATMENT.—The first indication is to restore the secretory functions of the kidneys. To this end we may apply **dry cups**, **leeches**, **hot poultices** over the loins and administer **bland diuretics**. It is often found that the action of diuretics is delayed until the bowels have been well emptied by means of **salines** or **elaterium**. Calomel, sometimes recommended, tends to irritate the kidney, and should not be used. The use of the **hot pack** or of **diaphoretics** will hasten and assist the action of a diuretic. **Venesection** is a valuable measure, especially in puerperal and acute inflammatory cases. **Lumbar puncture** is in many instances helpful. **Gastric lavage** has also been used for the latter purpose. Saline solution should be avoided, owing to retention of the chlorides and the likelihood of increasing the hydremia, besides disturbing the osmotic balance.

If the blood-pressure is high and the pulse tense, **nitroglycerin** is indi-

cated. Anders recommends its free use, and combines it with aconite, 2 minims (0.12 Gm.), the dosage being adjusted to the intensity of the vascular tension. **Amyl nitrite**, inhaling 10 drops, is very efficient, with **spirit of nitrous ether**, to sustain the effect. If the heart's action becomes feeble, **digitalin**, **caffeine**, or **strophanthus** may be used, but not if the blood-pressure is still high.

An essential feature is the **withholding of all foods** during an attack of uremia. Frequent irrigation of **warm water** will, besides keeping the bowels free, enable the body to absorb water, if it needs it.

C. E. DE M. SAJOUS,
Philadelphia.

UREA, DETERMINATION

OF.—Normal human urine contains from 1 to 3 per cent. of urea. If much less than 1 per cent. the patient is retaining poisonous products that should be eliminated; if more than 3 per cent. his loss is greater than his gain and his metabolism is on the down grade. For a man on a mixed diet the daily average excretion of urea varies from 24 to 40 grams, average 33 grams; on a non-nitrogenous diet or while fasting the excretion will vary from 15 to 20 grams. Women excrete rather less, from 20 to 32 grams. As much as 100 grams have been excreted when a very rich protein diet was used.

SPECIFIC GRAVITY METHOD.

As urea is the main factor in the specific gravity of urine, the latter is an approximate measure of the amount of urea, if the urine contains no sugar. From long observations it has been found that a specific gravity of 1014 corresponds to about 1 per cent. of urea, of from 1014 to 1020 to about 1.5 per cent., of from 1020 to 1024 to about 2 or 2.25 per cent., and of 1028 to about 3 per cent. This will not hold good in fever and cachexia, where diminished chloride excretion is the rule. Sugar, if present, must first be removed by fermentation in applying this method.

SODIUM HYPOBROMITE

METHOD.—The estimation by this method may be quickly made by use of the Doremus ureometer. This consists of a specially constructed tube with graduations and a pipette capable of measuring one cubic centimeter. The reagent used is the hypobromite of soda. This solution is, however, unstable and is commonly made for each test; but the formula devised by the late Dr. Charles Rice of Bellevue Hospital enables the physicians to keep on hand two stable solutions ready for use and obviates the necessity of opening a bottle of bromine every time a test is made. They are easily prepared, but pure chemicals should be used.

This method, though easy of application, is not entirely reliable, as urea is not completely decomposed by sodium hypobromite in the concentrations occurring in the urine, and a number of other nitrogenous compounds, as ammonia, creatinin, etc., suffer partial decomposition and vitiate the result. Occasionally one of the two errors mentioned neutralizes the other (C. G. L. Wolf).

SOLUTION A.

Sodium hydroxide 40 Gm.
Distilled water 100 c.c.

SOLUTION B.

Bromine 12.5 Gm.
Sodium bromide 12.5 Gm.
Distilled water 100 c.c.

For use, take 1 part of each solution and 3 parts of water.

In making the determination fill the tube with the sodium hypobromite so that no air remains in the blind end. Then with the pipette measure 1 c.c. of the urine and carefully and quickly pass its curved beak back into the bottom of the filled tube as it is tilted forward, to prevent escape of gas. Then gently pass the urine out of the pipette by means of the nipple attached, until it is entirely emptied. The lighter urine rises to the top through the hypobromite solution and its urea is decomposed, giving off two gases, one of which is reabsorbed; the other, the nitrogen, is collected at the top, and as soon as the frothing ceases the quantity of urea may be read off directly by means

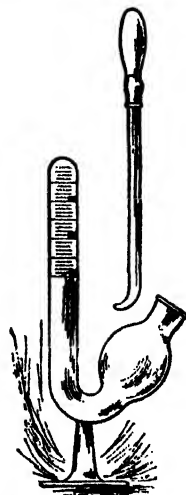
of the metric graduations on the tube giving the percentage.

If, as is rare, the urine contains more than 3 per cent. of urea it will be necessary to do the test again, using urine diluted half with water and of course multiplying the percentage thus obtained by two.

DAVY'S METHOD.—Pour a measured quantity of urine into a graduated (metric) tube partly filled with mercury, add an excess of the hypochlorite of soda and invert the tube. In a few seconds decomposition of the urea commences, the carbonic acid is absorbed by the hypochlorite and the nitrogen collects in the upper part of the tube, from which the urea content may be easily calculated.

BENEDICT'S METHOD.—In this method a sulphuric acid bath is required which must be kept at a temperature of from 162° to 165° F. The technique recommended for the estimation of urea in urine is as follows: 5 c.c. of urine are introduced into a rather wide test-tube, and about 3 grams of potassium bisulphate and from 1 to 2 grams of zinc sulphate are added. (The quantities of these salts may be measured roughly. An excess of the zinc salt is to be avoided, as too large a quantity tends to cause slight frothing during the final distillation.) A bit of paraffin and a little powdered pumice or talc are then introduced into the tube (to prevent frothing and spattering) and the mixture boiled practically to dryness, either over a free flame or, more conveniently, by floating the tube in a bath of sulphuric acid kept at about 130° F. The tube is then placed in a sulphuric acid bath which is maintained at from 162° to 165° F. (not lower), and left there for one hour. During this heating the tube must be weighted (a large-sized screw-clamp is convenient), so that it will be immersed in the acid for at least three-fourths of its length. At the end of the hour the tube is removed from the bath, the acid washed off under the tap, a little distilled water poured into the tube, and the contents washed (with the aid of heat) quantitatively into an 800 c.c. distillation flask. (A small amount of black pigment finally adhering to the sides of the tube may be disregarded, as the

ammonium compounds are readily soluble.) The fluid in the distillation flask is diluted to about 400 c.c., rendered alkaline through the addition of 15 to 20 c.c. of 10 per cent. sodium hydroxide (or 25 c.c. of 15 per cent. sodium carbonate), and distilled for forty minutes into an excess of standard acid. The residual acid is then titrated, and the urea nitrogen calculated (after subtraction of the previously determined ammonia nitrogen). In dextrose-containing urines this method may be employed in combination with the Mörner-Sjöqvist method.



Doremus's ureometer.

FOLIN'S METHOD.—This method is based on the fact that urea, when boiled with saturated solutions of magnesium chloride, is converted into ammonia. Five c.c. of urine, 20 Gm. of crystalline magnesium chloride, and 2 c.c. of hydrochloric acid are placed in a flask, closed with a reflux condenser of the shape given in cut. The mixture is heated on an electric stove for 90 minutes, the heat being greatest in the beginning and reduced toward the end of the reaction. The heat is so regulated that drops of liquid falling from the condenser emit a marked hiss when they fall upon the contents of the flask. The flask is now cooled and to its contents are added 500 c.c. of distilled water. The diluted contents are transferred quantitatively to a distilling flask. Ten c.c. of

sodium hydroxide, a little talc and a small piece of paraffin are added to prevent frothing. The distillate is received in a definite volume of standard sulphuric acid and finally titrated with alkali. A control estimation must be made to ascertain the ammonia contained in the 20 grams of the magnesium chloride, as it is seldom ammonia-free. The preformed ammonia must also be estimated, and subtracted from that of the total ammonia found by this method.

The foregoing method is conceded to be one by which we may accurately estimate the urea nitrogen, and is growing in favor with the great majority of laboratory workers.

MARSHALL'S METHOD.—This method is said to be peculiarly useful in its application to pathological urines since the presence of glucose and protein, usually so annoying in the estimation of urea, are without influence here. In the preparation of the enzyme solution, soy beans are ground to a fine powder which can be preserved in well-stoppered dry bottles for months without appreciable loss of activity; 25 grams of this powder are mixed with 250 c.c. of distilled water, and allowed to stand with occasional agitation for about an hour; 25 c.c. of N/10 hydrochloric acid are now added and the mixture allowed to remain a few minutes longer (best in a water bath at about 35° C.—95° F.), when a large proportion of the protein of the bean extract is precipitated. The mixture is filtered; the filtrate treated with a few drops of toluene and preserved for use in a stoppered vessel. On standing the originally clear fluid becomes opalescent, and finally a precipitate is formed, but the solution remains sufficiently active for use in the method at least five days after its preparation when kept at the room temperature. This solution is alkaline to methyl orange, and 2 c.c. generally require from 0.28 to 0.34 c.c. N/10 hydrochloric acid for neutralization. This factor should be determined once for 2 c.c. of each preparation and can then be employed as a correction as long as the solution is used. The alkalinity is apparently constant from day to day. If for any reason the extract should not be distinctly alkaline to methyl orange, less

acid should be used in its preparation, as an extract which reacts acid to methyl orange is scarcely active.

In the execution of the method 2.5-c.c. portions of the urine are measured into flasks of 200-300 c.c. capacity and diluted with distilled water to about 100-125 c.c.; 2 c.c. of enzyme solution are added to one flask, a few drops of toluene to each and the solution allowed to remain, well stoppered, at room temperature over night. The fluid in each flask is titrated to a distinct pink color with N/10 hydrochloric acid, using methyl orange as an indicator. The amount of hydrochloric acid required for the contents of the flask containing the urine and enzyme solution less the amount used for 5 c.c. of urine alone and that previously determined for 2 c.c. of enzyme solution, corresponds to the urea originally present in the sample of urine.

Since 1 c.c. of N/10 hydrochloric acid is equivalent to 3 mg. of urea, the number of cubic centimeters required multiplied by 0.6 gives the value of urea expressed in grams per liter of urine. The time required for complete hydrolysis of the urea depends on the quantity of urine used, the concentration of the urea, the amount of enzyme present and the temperature of action. The velocity of the reaction is approximately twice as rapid at 35° C. as at 25° C., and directly proportional to the enzyme concentration within certain limits. The conversion is complete in less than one hour at 35° C., when 10 c.c. of the enzyme solution are employed instead of 2 c.c. A cloudiness, however, is produced on titrating a solution containing 10 c.c. of the enzyme mixture, which renders the end point uncertain and the procedure less accurate. With the use of only 2 c.c. of enzyme solution this cloudiness is scarcely noticeable.

If more rapidity is required than is attained by the method as outlined, digestion for three hours at a temperature of 35-28° C. will suffice, or, if accuracy is to be sacrificed to rapidity, less urine and more enzyme solution can be used. A rough estimate may thus be obtained. W.

URETERS. See KIDNEYS AND URETERS, DISEASES OF.

URETERS AND BLADDER, EXAMINATION OF.—CYSTOSCOPY.

Cystoscopy consists in inspection of the interior of the bladder after insertion of an instrument which illuminates the organ and also magnifies the image from its internal surfaces—the cystoscope.

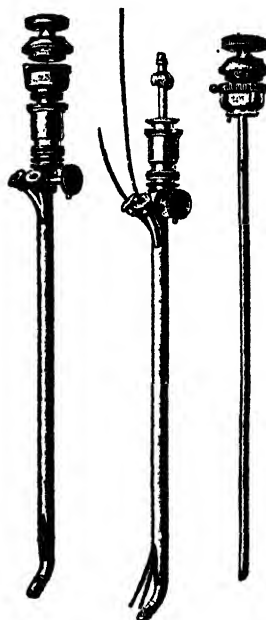
Varieties of Cystoscope.—Cystoscopes are classified as *direct* or *indirect*, according as the line of vision from the point inspected is straight or is deflected by a prism. In the indirect cystoscopes a rectangular prism near the distal extremity of the instrument refracts the incoming light rays at an angle of 90° and also inverts the image. The indirect variety of cystoscope is in more general use than the direct. It permits of backward inspection in the direction of the prostate.

Cystoscopes are also classified as *non-irrigating*, *irrigating*, *catheterizing*, and *operating* cystoscopes. In the irrigating instrument provision is made for changing the fluid in the bladder, where vision becomes dim because of turbidity due to blood or pus, without removal of the instrument. In many instruments, continuous irrigation—often a necessary procedure—is provided for. With the Nitze instrument, however, the irrigation is discontinuous, an inward flow of fluid, followed by an outward flow, being produced.

Catheterizing cystoscopes may be of either the direct or the indirect type. In the former the catheterizing tubes are propelled directly from the shaft of the cystoscope into the ureters; in the latter, they are curved or displaced toward the ureters by levers operated with thumb-screws from the external portion of the instrument. The Brown-Buerger prismatic (indirect) and the Tilden Brown direct catheterizing cystoscopes are in common use; irrigation is provided for in both of these instruments. The ureteral openings are more readily located with the indirect instrument than the direct, but the process of catheterization itself is easier with the latter.

Operating cystoscopes comprise instruments such as those of Nitze and Bransford, Lewis, and the Caspar modification

of the Nitze. These cystoscopes are of value in removing bits of calculi or other foreign bodies from the bladder or ureteral openings, in breaking up small calculi, in dilating ureters contracted at their lower terminations, and in applying remedies to vesical ulcers. Their use to remove papillomas is, however, inadvisable, the base of such growths remaining and later tending to become malignant.



Nitze's double catheterizing cystoscope with attachment for irrigation of the bladder. (Morton.)

In women the Kelly cystoscope, consisting essentially of a tube through which light is directed with a mirror, is widely used.

Preparation of the Cystoscope for Use.

Careful sterilization of the instrument before use is required, cystoscopy necessitating a perfect aseptic technique. The instrument should, if possible, be first taken apart and thoroughly cleansed with **green soap** in water. It should then be placed in a 1 to 500 formaldehyde solution for five minutes, or exposed to formaldehyde gas for an hour or more, to be followed by washing with **saline solution**.

A 5 per cent. solution of **phenol** may be used instead, but exposure to it for twenty-four hours is desirable; before use the phenol is washed off with **glycerin**. **Alcohol** may likewise be employed, but immersion of the eye-piece in it must be avoided.

Before introduction of the instrument it should also be connected with the rheostat and proper lighting of the small electric bulb at its tip made sure of. It should likewise be known that the bulb used is actually a "cold" lamp, burns of the bladder mucosa sometimes occurring where a hot bulb is left in contact.

Lubrication of the cystoscope is effected with sterile **glycerin**.

Preparation of the Patient.—The passage of **steel sounds** for a few days before cystoscopy is of advantage in creating a tolerance of the urethra which facilitates the introduction of the instrument. In certain cases a preliminary **meatotomy** or **urethrotomy** is required. Where the patient's general condition is poor, or retention of urine exists, prophylactic administration of 15 grains (1 Gm.) or more of **hexamethylenamine**, in divided doses on each of the two preceding days, is advisable.

Special cystoscopic tables upon which the subject is maintained in a semireclining posture with the knees apart and raised somewhat above the level of the pelvis are on the market. The procedure can, however, be carried out almost as conveniently on any other form of table, including those available in the ordinary household. A sterile covering should be placed over the subject's legs, as little as possible being left exposed other than the penis, which should be carefully cleansed with **tincture of green soap and water**, followed by **mercury bichloride solution**, then surrounded with a sterile wet dressing.

General anesthesia is required only in the case of greatly hypersensitive urethras, and in children. To nervous adult subjects $\frac{1}{4}$ grain (0.015 Gm.) of **morphine sulphate** may be given. In the average case, **local anesthesia** with 2 per cent. **cocaine**, or, preferably, one of the newer, less toxic drugs, such as **alypin** or **novocaine**, is sufficient. The anesthesia is best

secured by the use of an instillator, such as the Keyes-Ultzmann instrument, 1 fluidram (4 c.c.) of the **cocaine solution**, or slightly more of a 5 per cent. **alypin** solution being introduced. A large portion of the anesthetic solution should be instilled in the posterior urethra, the remainder being used for the anterior. Ten minutes should be permitted to elapse for the anesthetic to act.

Technique of Cystoscopy.—When certain of the older forms of cystoscope are used, the bladder must be irrigated and filled through a rubber or silk catheter before the introduction of the instrument. Usually, however, these procedures are carried out through the sheath of the cystoscope itself or its irrigating attachment. Before the instrument is introduced it should be well lubricated and the light turned on. The introduction itself is performed as with the ordinary metallic sound, the shaft being first held close to the abdomen as the penis is worked up along it, the instrument next allowed to settle into the curved portion of the urethra below the pubis, and the shaft then carried gently down between the thighs until its beak slips through the neck of the bladder. In difficult cases the introduction may be facilitated by deep pressure above the pubis or by inserting a finger in the rectum as a guide to the tip of the instrument.

The cystoscope having entered, the bladder is repeatedly in part filled with **sterile warm water**, normal **saline solution**, or 2 per cent. **boric acid solution**, and allowed to re-empty itself. When the outflow is found to be absolutely clear, the bladder is redistended with the fluid until the patient experiences a slight desire to pass water. The investigation of the bladder may then be proceeded with. Throughout, such lifting of the instrument from the exterior as will raise its tip from the trigone of the bladder—compression or injury of which is chiefly responsible for pain and bleeding induced in cystoscopy—should be, as much as possible, carried out.

Removal of the cystoscope is performed merely by reversal of the steps gone through in its introduction. It should preferably be preceded by evacu-

ation of the fluid in the bladder and introduction of some dilute antiseptic solution, *e.g.*, 1:10,000 silver nitrate, to be again passed after the cystoscope has been withdrawn.

Uses of Cystoscopy.—Cystoscopy has come to occupy a most important place in urinary surgery, not only permitting of precise diagnosis in conditions formerly guessed at, but greatly improving the chances of complete operative relief in affections, especially renal, in which intervention was formerly so postponed as frequently to lose its curative value. Thus by cystoscopy we gain definite information not only as to the presence of foreign bodies in the bladder, tumors, stones, cystitis, malformations, etc., but also as to the condition of the kidneys themselves. The procedure is indicated in all puzzling conditions of the bladder, kidneys, and ureters, except in the presence of acute inflammation anywhere in the lower urinary or genital tract. It is invaluable in the determination of the origin of **hematuria** and **pyuria** not due to disease of the urethra, and in affections of structures adjacent to the bladder may be employed to ascertain whether this organ is likewise being attacked. In cases of pronounced prostatic enlargement it is, however, at times unsatisfactory or impossible, and is contraindicated—unless preceded by drainage of the bladder—where there is pronounced sepsis from retention of urine in these cases.

In using the indirect cystoscope the vault of the bladder is usually inspected immediately after the introduction of the instrument. Next, upon drawing the latter out to the sphincter, the internal opening of the urethra is examined. Finally, the condition of the side walls, the base, and the openings of the ureters is inquired into.

In **cystitis** the mucous membrane will be found reddened, and the vessels normally forming a red network on the yellowish-pink membrane itself will have disappeared, being obscured by the surrounding diffuse red coloration. In addition, erosion, hemorrhage, ulceration, trabeculation, or sacculation may be noticed.

In **tuberculosis of the bladder** tubercles and ulcerations will be found extending

from the neck of the bladder or the orifices of one or both ureters as centers to any of the remaining surfaces of the organ.

Tumors of the bladder are detected through the cystoscope even better, especially when small, than by inspection of the incised organ. As in tuberculosis, the disease is most likely to be found near the ureteral and urethral openings. The entire organ should, however, be carefully examined, using the direct cystoscope to inspect areas not illuminated by the indirect, in order that no focus for subsequent recurrence be left when operative removal is undertaken. Hemorrhage due to bladder tumors will readily be differentiated by cystoscopy from renal hematuria.

Prostatic enlargement encroaching on the bladder lumen is revealed by cystoscopy even where, as is sometimes the case, rectal palpation is negative. Pronounced lowering of the outer end of the instrument between the thighs may be necessary in these cases to permit the instrument to ride over the prostatic obstacle during its passage into the bladder. An indirect cystoscope must be used. The instrument having been introduced deeply, it is slowly drawn out until the prostate appears as a rounded, reddish organ, the exact intravesical conformation of which is then appreciated by gradually turning the cystoscope and by noting the extent to which the instrument has, at different points, to be pushed in or withdrawn to keep the margin of the prostate in view. A hypertrophied median prostatic lobe may, owing to its elevation, eclipse the "bar" normally visible between the ureters, and may alter the shape of the trigone and disturb the normal relationship of the ureteral openings or even hide them. Where there is retention of urine cystoscopy should be availed of, according to Keyes, only for the diagnosis of stone or as a preliminary to operation.

Among other conditions in which cystoscopy is of diagnostic value are **carcinoma of the prostate**, **varicose veins of the bladder**, and **ureteral cysts** so situated as to be visible in the bladder cavity.

In **renal affections**, unless incipient,

considerable information may be gained by inspection of the ureteral orifices. An appearance of **cystitis** round one of these openings is, to some extent, indicative of renal trouble above. Frequently in kidney infection the ureteral opening is either dilated or contracted. Ulceration may likewise be noted, and if the normal jets of urine from the ureters are lacking, extensive disease of the ureters and presumably of the kidneys is shown. Where there is marked renal suppuration the purulent character of the urine excreted by it may be manifest as the fluid appears at the ureteral outlet.

Tuberculosis of the kidney is especially suggested (1) by shallow, crateriform ulcers with clearly defined congested margins and necrotic bases, situated at or near the ureteral opening, and (2) by displacement of the vesical trigone to the affected side, with funnel-shaped depression of the ureter mouth on that side, due to shortening of the diseased and thickened ureter. Sometimes there is no apparent ureteral change in spite of pronounced tuberculous involvement of the kidney.

In **nephrolithiasis** a calculus may occasionally be noted projecting from the ureteral opening. **Stones in the bladder** inaccessible to the searcher are also revealed by cystoscopy. In using the operating cystoscope for removing **foreign bodies from the bladder** or breaking up small stones in it, air instead of fluid is generally used to distend the organ, the manipulations usually causing so much bleeding as to obscure vision in the bladder, in spite of continuous irrigation.

Extravesical conditions altering the internal appearance of the bladder are especially common in the female sex, owing to the proximity of the reproductive organs, with their varied pathology. **Cystocele** causes distortion of the vesical trigone and may obscure the ureteral openings; cystoscopy may give a better idea of the exact size of the cystocele than mere vaginal inspection. Acute **uterine ante flexion** or **enlargement of the uterus** from pregnancy or other causes are reflected in pronounced depression of the posterior vesical wall or vault and sometimes in vascular stasis in a part of

the bladder. **Cystoscopy** is of special service in such cases in ascertaining whether the **extravesical process** has caused adhesion to the bladder, such adhesion causing, *e.g.*, edema and folds of the mucosa, varicosities, areas of submucous hemorrhage and, in the case of tumors or serious inflammatory processes, actual invasion of the bladder-wall by the disease, possibly followed by perforation and fistula formation. Thus, in **cancer of the cervix** venous congestion in the lower portions of the bladder suggests involvement of the vesicovaginal septum, and the degree of operability of the condition is shown by observation of the extent of retraction of the bladder and of elevation of the vesical trigone. In men, extravesical conditions that may influence the cystoscopic appearance of the bladder include, in particular, **affections of the prostate, rectum, and sigmoid**.

Ureteral catheterization is indicated for purposes of accurate diagnosis in all instances of suspected **surgical disease of the kidneys**; in **obstinate bladder inflammation**, to find out if the kidneys are involved, and in cases of suspected **calculus in the ureter**, the catheter being used to find out the exact situation of the stone or facilitate its discharge, or in radiography, to bring out the situation of the ureters on the plates. In **renal tuberculosis** ureteral catheterization is almost indispensable, affording certain knowledge as to which kidney is chiefly or exclusively diseased and giving definite operative indications. In **hydronephrosis** the procedure may be used to estimate the capacity of the renal pelvis—colored fluid being injected into the pelvis, then allowed to run out—and to fill the pelvis and ureter with some opaque silver preparation (**collargol** or **argyrol**) preliminary to X-ray examination. Both in **hydronephrosis** and in **nephrolithiasis** and **ureteral stone**, ureter catheterization is of great importance in ascertaining the functional value of the kidney before operation is undertaken. The technique of ureteral catheterization is described in volume vi, pages 226 and 227.

Urinary segregation consists in obtaining the **urines of the two kidneys separately** by the insertion of an instrument

which partitions off the two sides of the bladder. The Luy's separator, consisting essentially of a metal sound in the curve of which a rubber diaphragm is stretched up with a small chain after the instrument has been introduced, is generally employed.

The method is, in fact, merely an inferior substitute for ureteral catheterization, and its indications are practically limited to cases in which, for some reason, the ureteral orifices cannot be located while no distortion of the bladder sufficient to prevent the use of the separator exists.

T. and S.

URETHANE.—Urethane (*Æthylis carbamas*, U. S. P.), $C_2H_5CH_2NO_2$, is an ester of carbamic acid and obtained by the reaction of alcohol upon urea or one of its salts. It occurs in columnar colorless crystals or scales, having a faint, peculiar odor, and a cooling saline taste like salt-peter. It is soluble in less than its own weight of water, 0.6 part of alcohol, 1 part of ether, 1.3 parts of chloroform, and 3 parts of glycerin. It is incompatible with alkalis, acids, antipyrin, butyl-chloral hydrate, camphor, carbolic acid, euphorin, menthol, betanaphthol, resorcinol, salol, or thymol, in trituration.

As a sedative it is given in doses of from 10 to 20 grains (0.6 to 1.3 Gm), in powder, capsule, or solution, one to four times daily, as a hypnotic, 30 to 45 grains (2 to 3 Gm), in 3 portions at one-half to one hour intervals, in 10 per cent. solution. The maximum single dose is 75 grains (5 Gm); the maximum daily dose is 150 grains (10 Gm).

PHYSIOLOGICAL EFFECTS.—Ethyl carbamate is a hypnotic resembling paraldehyde in its physiological action, but lacks its unpleasant taste and odor. When effective the sleep produced is quiet and tranquil, and generally without depression or other unpleasant after-effects.

POISONING BY URETHANE.—When given in overdose urethane causes distinct depression of the respiratory centers, the heart, and the spinal cord. Death from a fatal dose is due to asphyxia.

Treatment of Poisoning.—The treatment for poisoning by this drug is the same as that recommended for paraldehyde poison-

ing (vii, 391): atropine, strong coffee, electricity and respiratory stimulants.

THERAPEUTIC USES.—Urethane is employed for its hypnotic, antispasmodic, or sedative effects in nervous or functional insomnia, eclampsia, nervous excitement, tetanus, and as antidote in poisoning by strychnine, resorcinol, or picrotoxin. W.

URETHRA. See URINARY AND GENITAL SYSTEMS, SURGICAL DISEASES OF.

URINALYSIS. See INDEX under titles of various abnormal conditions of urine: ALBUMINURIA, LACTOSURIA, TYROSINURIA, etc.

URINARY AND GENITAL SYSTEMS, SURGICAL DISEASES OF.—DISEASES OF THE URETHRA.

ANOMALIES OF THE URETHRA.

—Congenital occlusion and entire absence of the urethra are very rare. Occlusion is usually due to a thin membrane, which may be broken through with a bougie or trocar and cannula. If firmer, it may be divided with an appropriate knife (tenotome), or by external incision, either with or without suprapubic cystotomy and retrograde catheterism, according to its situation and extent.

Transplantation of mucous membrane from the cheek may be tried to make good the defect in the urethral lining.

Congenital stricture of the urethra is relatively common, occurring chiefly at the meatus, rarely in the membranous urethra. The latter type is treated in the same manner as acquired stricture. Stricture at the meatus in exceptional cases induces reflex symptoms of irritation or the manifestations of urinary retention, and is treated by **meatotomy**. After suitable cleansing of the parts, a $\frac{1}{10}$ -grain (0.006 Gm.) tablet of cocaine is placed in the recess behind the strictured meatus and dissolved with a drop or two of adrenalin solution. When blanching follows, the membrane is cut with a blunt-pointed bistoury and a packing of cotton dusted with iodoform inserted.

Urethral pouches, usually just behind

the glans, distending during micturition and causing subsequent dribbling, are occasionally noted, and may be remedied by removal of the redundant tissues and suture of the mucous membrane and skin.

EPISPADIAS.—Epispadias, or absence of the roof of the urethra, is occasionally met with. It may be either complete or partial. In the former variety the entire roof is absent and there is also exstrophy or absence of the anterior wall of the bladder and the overlying portions of abdominal wall, resulting in complete incontinence of urine.

Treatment.—In partial epispadias of sufficient extent to demand relief closure of the defect by operation is indicated. If there is plenty of material the edges may be freshened and brought together over a catheter by means of sutures. If not, a flap may be taken from the anterior abdominal wall and turned downward to form the new roof of the urethra. If necessary, the penis may be first straightened by making one or more deep transverse incisions across its dorsum, each of which is then sutured so that its ends are approximated.

Thiersch's operation is performed in four stages. The first is the formation of that portion of the canal which normally is situated in the glans. The second stage is the formation of the remainder of the roof of the urethra, two flaps of suitable length being made from the integument on the dorsum of the penis. The third step is intended to close the small space between the two previous operations. The fourth step consists in closing the space between the posterior portion of the new urethra and the orifice leading to the bladder.

Enough time should be allowed between each of these steps for perfect healing. The operation is generally not immediately successful throughout, fistulae often forming and portions of the flaps failing to unite, so that the total period of treatment is frequently prolonged.

The method of operating for exstrophy of the bladder is described under that heading.

HYPOSPADIAS.—This is a congenital defect in which the floor of the urethra is absent. According to Bouisson it oc-

curs in 1 out of every 300 males. It is usually associated with downward curvature of the penis. The deficiency may be small or large, the cases being grouped, according to the position of the urethral orifice, into (1) balanic, with the meatus at the base of the glans; (2) penile, with the meatus at any point along the pendulous urethra; (3) perineal, with the meatus in the perineum.

The cause of hypospadias is arrest of development. The diagnosis is readily made upon inspection.

Treatment.—It is usually unnecessary to interfere in cases of the balanic variety.

In the other cases the treatment consists in straightening the organ and forming a proper canal. The former is accomplished by making one or more transverse incisions through the skin and any bands of tissue which tend to hold the organ in the abnormal position. It is occasionally necessary to carry the incision into the corpora cavernosa. The incisions should be united by sutures in a longitudinal direction, the long axis of the wound being thus at right angles to the line of the original incision. The penis is to be held by dressings upward against the body until the next step in the operation is to be carried out.

According to the method of Nové-Josseland, a stout probe, then a catheter, are passed beneath the skin from the hypospadiac meatus to the glans and through the latter. The new urethral canal is formed by wrapping an Ollier skin-graft, 4 cm. wide, from the inner side of the thigh, outside in around the catheter, passing it under the skin already raised, and holding it in place with sutures of 00 catgut. In the Rochet modification of this operation an elongated flap from the scrotum, with its narrow base at the hypospadiac opening is wrapped outside in round the catheter instead of the Ollier graft.

In some cases where the defect is in the anterior half of the urethra, it will be found advisable to make use of the redundant prepuce. An incision is made through both layers of the prepuce on the dorsum close to the corona. The glans is slipped through this incision, the 2 layers of the transposed hood of dorsal

prepuce separated, beginning at its cut edge, and the raw surface thus formed made to cover over that which resulted from turning flaps over a catheter to form a new urethra (**Wood's operation**).

Beck's operation, at times employed where correction of a balanic hypospadias is insisted upon by the patient, consists in liberating the urethra for some distance behind the orifice, pulling it forward through a channel punched in the glans, and sewing it to the apex of the latter.

INJURIES OF THE URETHRA.—

Wounds of the urethra may be produced from without or within. Incised wounds from without, if longitudinal, heal readily. If transverse, there is much bleeding and the proximal end, in case of complete section, retracts. The divided ends should be secured and apposed with interrupted catgut **sutures** $\frac{1}{8}$ inch apart and not passing through the urethral epithelium. Subsequent **continuous catheterization** for several days is indicated, with frequent **antiseptic irrigations** of the urethra and bladder.

Punctured wounds from without will probably require a permanent rubber **catheter** for some days and a **lead-water** and **alcohol dressing** over the external wound. Full-sized **urethral bougies** should later be passed at intervals to prevent undue scar contraction.

Lacerated wounds from without, involving the urethra, require a **permanent catheter**. The urethra should be united over this with fine catgut **sutures** if possible. The external wound should be allowed to heal by granulation usually. Exceptionally, clean wounds in favorable condition may be closed by **primary suture**. Careful suturing of the urethra will do much to prevent stricture formation. At the end of a week or ten days the catheter may be removed, after which a **steel bougie** should be introduced at regular intervals.

Injuries of the urethra produced from within—usually false passages caused by attempts at passing metal instruments in cases of stricture—require mild **antiseptic irrigations** of the urethra (1 to 2000 **pre-targol** or 1 to 6000 **potassium perman-**

ganate solution) and the internal use of **urinary antiseptics**.

RUPTURE OF THE URETHRA.

—This occurs chiefly either behind an old tight stricture or from a fall in which the patient alights astride some sharp object, such as the edge of a board or a rail. Occasionally it results from fracture or disjunction of the pubic bones, "breaking" chordee, or some other form of traumatism.

Symptoms.—In cases due to stricture a small, painful swelling will usually appear at some point along the urethra. This may form an abscess, or may give rise to a rapidly spreading cellulitis, with the usual signs of inflammation. Upon inquiry it will be found that the stream of urine has been gradually diminishing in size, and that it has been passed with increasing difficulty. There may be complete retention.

Rupture of the urethra from alighting astride a sharp object or from injury of the pubes occurs in the membranous portion; from "breaking" chordee or other rare forms of trauma, in the pendulous portion. Pain, hemorrhage, and retention of urine are the common symptoms in these cases. Swelling and ecchymosis may or may not exist, depending at first upon the nature of the accident and later upon whether there is extravasation of urine or not. There may be immediate perineal swelling due to extravasated blood. The pain is usually not severe. Bleeding from rupture in the pendulous urethra always appears at the meatus. That from the membranous urethra may also appear at the meatus or flow back into the bladder and lead to hematuria. In rupture of the pos-

terior urethra both bleeding from the meatus and perineal swelling may be absent. Complete retention of urine may immediately follow the accident, due to extensive laceration, or occur after some hours, as a result of swelling and blood-clot. If the case is not seen early, and a permanent catheter introduced, extravasation of urine will probably occur at the point of rupture, with rapidly spreading cellulitis.

In all forms of urethral rupture, a subsequent traumatic stricture is almost inevitable. The mortality from the condition is, however, relatively low, Terrillon reporting 12 deaths among 170 cases.

Treatment.—In suspected rupture of the urethra, the parts should be inspected for any external evidences of injury. Inquiry should be made as to the appearance of blood at the meatus and as to whether urine has been voided. In the milder form of rupture of the pendulous urethra, giving rise to merely a sharp pain, slight bleeding, and a few painful micturitions, **expectant treatment** is indicated. The patient should be put to bed, **purgation** instituted, **hexamethylenamine** given internally, and 3 to 5 c.c. (48 to 80 minims) of 1:2000 **silver nitrate** or 1:1000 **protargol** solution injected into the anterior urethra twice a day, **catheterization** being avoided unless dysuria or retention of urine demand it. The subsequent scar contraction, generally starting six weeks after the injury, will later require treatment.

In more severe cases, with considerable bleeding, interference with urination, and a decided hematoma, an attempt should be made to pass an **elbowed** or **soft-rubber catheter** of

small or medium size, after thorough cleansing of the glans and prepuce. The catheter, previously boiled, should be connected with a **fountain-syringe** containing an **antiseptic solution**, then oiled in **carbolyzed vaselin** or other suitable lubricant, the solution permitted to pass for a moment, and finally, the catheter slowly and very gently introduced, the fluid flowing meanwhile. The urethra is thus thoroughly irrigated, the fluid escaping around the catheter. Among appropriate antiseptic fluids are: **potassium permanganate**, 1:5000; **bichloride of mercury**, 1:10,000; **phenol** 1:500, and **boric acid**, 10 or 15 grains to the ounce of sterile water. If the catheter passes into the bladder easily, the urine should be withdrawn with it every six or eight hours. If the catheter passes only with difficulty and after repeated efforts, it should be allowed to remain, securely held by any appropriate means. If it fails to pass the point of rupture, other sizes or forms may be tried. The **Nélaton catheter** is very useful, the point being kept on the roof of the urethra, which in partial tears is less apt to be involved than is the floor. If a catheter enters the bladder it should be allowed to remain.

If no catheter whatever will pass into the bladder, a **metal bougie** or other firm instrument should be introduced until it is arrested. Its point should then be exposed (this may be done under local anesthesia) by a median incision, thus guiding the operator to the distal end of the torn canal. The proximal end should then be sought. When found, a **soft-rubber catheter** should be passed into the bladder from the meatus, and the divided urethra sutured with fine,

chromicized catgut, if at all possible. In seeking the proximal end of the urethra, very careful search should be made in the wound before doing much dissecting, as this would add to the difficulty of locating it. When the usual means fail, suprapubic pressure will frequently cause urine to exude and thus indicate the urethra. The external wound should be united by sutures if conditions permit, drainage being introduced if necessary.

A catheter retained in the bladder should be kept clean by irrigation through and around it with boric acid or other mild antiseptic solution. It may be removed in from five to ten days, depending upon the extent of the injury. Subsequently steel sounds should be very gently passed every second day, gradually using larger sizes until the full caliber for the particular patient has been reached. After the wound has healed firmly the bougies must be continued, at first once a week; later, once a month, then with diminishing frequency for one or two years. In all cases a tendency to stricture formation persists throughout life, necessitating occasional use of the bougie indefinitely.

During the early treatment, with or without operation, the wound should be frequently examined to detect the earliest evidences of infiltration of urine if this should occur. This would indicate that the catheter was not efficiently draining the bladder. Extravasation, with swelling, pain, and heat, requires early and free incisions and frequent antiseptic irrigations and dressings.

According to Guyon and others, immediate external urethrotomy and suture are indicated in all cases of

perineal rupture as well as in severe injuries of the pendulous urethra, the ultimate results of suture being much superior to those of continuous catheterization. Where the loss of tissue has been too great to permit of suture, a perineal tube may be used for a few days, followed by permanent catheterization from meatus to bladder and later, if necessary, by a secondary operation for fistula closure.

Report of 3 cases in which a permeable channel was constructed after severe war wound of the urethra. A strip of vaginal mucosa from a patient subjected to colpoperineorrhaphy was wound around a bougie, raw surface out, fixed in place with fine silk, and introduced into a tunnel made for it in the subcutaneous tissues. Dilatation was begun on the seventh or eighth day. Success complete in 2 cases and fair in the third. Leguen (Paris *méd.*, June 1, 1918).

FOREIGN BODIES AND CALCULI IN THE URETHRA.—Symptoms.—May be absent, or be manifest as severe pain, hemorrhage, and retention of urine. Unremoved foreign bodies may form nuclei for stones in the urethra or bladder, or may excite urethritis and become encysted or ulcerate through, fistula and later stricture resulting. Urethral calculi may excite symptoms gradually—slight gleet, dysuria, and finally periurethritis and fistula formation.

Diagnosis.—External palpation may be supplemented by gentle searching with a sound, with pressure on the outside to keep the body from entering deeper, and by examination with a finger in the rectum.

Treatment.—Foreign bodies can sometimes be removed by injecting oil into the meatus, squeezing the latter shut, having the patient attempt micturition, and letting the meatus open when the urethra has become distended. A soft, long body may be extracted by repeatedly pushing the urethra back over it like a glove finger, thus gradually working it out; repeated transfixion of the body

through the urethra with a needle may be necessary to afford the required purchase on it. This method failing, a **wire loop** or **long urethral forceps** may be tried. Pins situated with their points outward can be removed by pushing their shaft through the urethra until the position of the head can be reversed, when the pin is pushed out of the meatus head foremost. In cases of stricture **meatotomy**, **urethrotomy** or **continuous dilatation** of the urethra may have to be performed before extraction with forceps becomes possible. If all these maneuvers prove unsuccessful, **perineal section** will be required. In cases of acute trouble from a calculus lodged in the posterior urethra, the stone can sometimes be pushed back into the bladder.

GONORRHEA.—DEFINITION.

—A contagious, specific inflammation of the mucous membrane of the urethra or vagina, accompanied by a mucopurulent discharge, and due to infection with the gonococcus, first described by Neisser.

In involvement of the urethral canal the condition is termed **gonococcal urethritis**. The disease may also be communicated to other mucous surfaces, most frequently the conjunctiva (see CONJUNCTIVA, DISEASES OF), and occasionally the rectum.

Inflammation of the urethra may result from causes other than the gonococcus, as described under the succeeding heading.

Gonorrhea usually results from sexual intercourse with a person suffering from the disease. It may be transmitted in occasional instances by means of contaminated towels or clothing, etc.

SYMPTOMS.—Acute Gonococcal Urethritis.—The commonest example of gonorrhea is that of the urethra in the male. The disease usually manifests itself within three to five days

after the intercourse. The first symptom is an irritation of the meatus, which becomes swollen and of a deeper red color than normal, and shows a slight, thin, whitish discharge. Urination usually causes considerable local smarting. The inflammation then extends backward and rapidly becomes more intense, so that in twenty-four to forty-eight hours the discharge has become profuse, thick, yellowish, and, in the severer cases, tinged with blood. Pain in urinating is very intense (*ardor urinae*). The patient has obstinate erections, especially at night, accompanied by severe pain. The characteristic phenomena known as *chordee* consists in a downward bending of the organ during erection due to loss of elasticity of the inflamed urethra, the corpora cavernosa meanwhile distending and elongating as usual; when this occurs the pain is especially severe.

Symptoms of *acute posterior urethritis* develop in a large percentage of initial gonorrheal infections, and appear usually between the fifth and the fifteenth days. The patient is obliged to urinate at very short intervals, and pain is experienced especially at the close of micturition. Swelling of the mucous membrane and periurethral tissues may be so marked as to greatly reduce the stream of urine. Blood may run from the urethra at the end of urination, and intense perineal pain may result from the pronounced tenesmus.

Subsidence of the urethritis starts, in the second or third week, at the meatus. Decline in the remainder of the anterior urethra begins about a week later, and in the posterior urethra very soon after. Gonococci and

a slight purulent discharge often persists eight to twelve weeks, though they may disappear in six.

The severity of each symptom varies widely in different cases. The first attack of gonorrhea nearly always causes more severe symptoms than subsequent attacks. A person who has once had gonorrhea, however, seems predisposed to urethral irritation or inflammation, doubtless induced by infectious or other causes so mild that a healthy urethra would remain unaffected. In this so-called *subacute* or *catarrhal* type of gonorrhea the chief symptom is the discharge, which is more watery than in the acute severe form. Gonococci and pus cells, often with a mixed infection, are to be found in relatively small numbers. Slight irritation on passing urine may coexist. Under treatment the discharge is soon reduced to the "morning drop."

Chronic Gonococcal Urethritis.—

Gonorrhea persisting longer than three months is arbitrarily considered as chronic, even though it be interrupted by acute exacerbations. It usually results from persistence of gonococci in the urethral lesions, yet other bacteria may alone be present (*postgonococcal chronic urethritis*). Chronic *anterior* urethritis is manifested merely in a purulent, semipurulent, or mucoid discharge (*gleet*) which may be intermittent. A sense of moisture about the meatus, or a gluing together of its lips in the morning, may alone be noticed. The so-called "clap shreds," however, are likely to occur in the urine. Chronic *posterior* urethritis, according to many, is practically synonymous with chronic prostatitis, the two conditions being clinically rarely distin-

guishable, and the latter almost always complicating the former. The symptoms include urethral discharge; disturbances of urination, *e.g.*, abnormal frequency or urgency, pain, slowness in starting or finishing, obstruction); the presence of clap-shreds in the second glass in the 2-glass test; reflex discomfort or pain along the penile urethra or in the perineum or back, and occasionally disturbances of the sexual function.

DIAGNOSIS.—A red and swollen meatus, with a whitish discharge, affords very suggestive—and pronounced swelling, with *ardor urinae* and chordee, almost conclusive—evidence of acute gonococcal urethritis. A positive diagnosis is made, however, only by finding gonococci in the discharge. This is effected as follows: A thin film of pus in a clean slide or cover-glass is dried at a gentle heat and fixed by passing quickly 3 times through an alcohol or gas flame. Paltauf's solution [aniline oil, 3 parts; absolute alcohol, 7 parts; distilled water, 90 parts; shake together for two minutes, filter till clear, and add 2 parts of Grüber's powdered gentian violet] is now applied for three minutes, the excess shaken off and the slide blotted, and Lugol's solution [iodine, 1; potassium iodide, 2; distilled water, 300] applied for exactly two minutes. The preparation is then washed with absolute alcohol for exactly $\frac{1}{2}$ minute, and counterstained with Bismarck brown [phenol, 2; saturated watery solution of Bismarck brown, 98] for three to five minutes. Examined microscopically under a $\frac{1}{12}$ oil immersion objective, the gonococci—coffee-bean shaped and occurring both intra- and extra-cellularly in

pairs, fours, or other multiples of 2—will exhibit a light-brown tint (being negative to Gram's test, *i.e.*, decolorized by the Lugol solution), while the pseudogonococci (positive to Gram's) will show a deep-purple, almost black color.

Culture of the gonococcus, carried out on a slightly alkaline medium containing human blood-serum, is rarely necessary in the diagnosis of urethritis.

In addition to the examination for gonococci, the diagnostic study in acute urethritis may appropriately include the 2-glass test, cloudy urine in both glasses signifying posterior urethritis, while if only the first is cloudy, posterior involvement may be absent. In chronic urethritis, the urethra may in addition be examined for periurethral nodules or stricture, the testicles for epididymitis, and any secretion expressed by massage from the prostate and seminal vesicles, for gonococci. Infiltrations of the anterior urethra may be detected with a well-lubricated No. 24 or 26 F. bulbous bougie. Accurate diagnoses of the conditions existing in special portions of the urethra may be made with one of the various forms of urethroscope adapted for examination of the anterior urethra or the Swinburne instrument, which illuminates the floor of the posterior urethra.

The *gonococcus complement-fixation test*, while conclusive when positive, is often negative in acute and sub-acute urethritis. It is chiefly of value in gonococcal arthritis, in pelvic involvements in women, in the vaginitis of female children, and in determining whether gonococcal infection has been eradicated in chronic urethritis.

COMPLICATIONS.—Acute anterior gonococcal urethritis may be complicated by periurethral abscess, due to the bursting outward of an abscessed urethral gland. The fistula resulting from its rupture at the surface usually heals spontaneously. Balanoposthitis, apparently due to mixed infection, may develop in persons with a long or tight prepuce, but yields easily to the customary measures (see PENIS, DISEASES OF).

Acute posterior urethritis may be complicated by acute prostatitis which, however, hardly excites any symptoms unless suppuration is already beginning (see ABSCESS OF THE PROSTATE). A mild trigonitis, as a rule, coexists. Seminal vesiculitis and epididymitis may also develop (see DISEASES OF THE SEMINAL VESICLES AND DISEASES OF THE PENIS AND TESTICLES). Pylonephritis and peritonitis are very rare complications of gonorrhea in the male.

The chief complication of chronic anterior urethritis is stricture, herein-after to be discussed. Follicular abscesses or abscesses of Cowper's glands may also be noted as shot-like nodules along the urethra, suppurating and keeping up a slight discharge for prolonged periods.

Chronic gonococcal urethritis is in the majority of cases complicated by chronic prostatitis; chronic seminal vesiculitis is frequently added to the latter disorder.

PROPHYLAXIS.—Relative safety after infective intercourse may be secured by immediate urination and **washing with soap and water**, followed by injection of a 20 per cent. argyrol or 1 per cent. protargol solution, to be retained five minutes. Such an injection must be made

within twelve hours if good chances of success are desired.

ABORTIVE TREATMENT.—In theory the abortive treatment of gonorrhea is ideal. It is successful, however, only in the very earliest manifestations of the disease, and in practice patients are rarely seen at this stage. After the gonococci have penetrated beneath the superficial layers of the epithelium, and the symptoms are well marked, this method should not be used. In adopting it, the surgeon should be guided to some extent by the patient's wishes. There are cases in which it is imperative to cut the disease short. It should be explained that the abortive treatment will be followed by considerable inflammatory reaction, and that it may fail to arrest the disease.

Given, therefore, a patient presenting himself within one to three days after exposure, with slight irritation at the meatus and a scant, watery discharge, the advantages and disadvantages of the abortive treatment should be fairly presented, and, if he so elects, the surgeon is justified in carrying out this method. The technique is as follows: The patient urinates, the **anterior urethra** is **washed out** with **sterile water** or **boric acid solution**, 10 drops of a 4 per cent. solution of **beta-eucaine** are injected, and a solution of **silver nitrate**, 20 grains (1.3 Gm.) to the ounce of distilled water, is applied to the first inch and a half or so of the urethra, either with a French pointed **urethral syringe** or a cotton swab introduced through an **endoscope**. The patient is then treated as for the early stages of acute gonorrhea. All the symptoms of acute anterior urethritis develop rapidly, and in successful

cases they gradually subside and disappear in a few days. In unsuccessful cases the disease runs the usual course.

Instead of this single, powerful application, frequent, copious irrigations of the **anterior urethra** with **potassium permanganate**, 1:2000; **mercury bichloride**, 1:5000; or **silver nitrate**, 1:1000 may be employed. By this method the patient is spared the discomforts of the more active treatment, but success is less likely.

Intermediate between the 2 methods is the injection, after local anesthetization of 1 dram (4 c.c.) of a 5-grain (0.3 Gm.) to the ounce (30 c.c.) solution of **protargol**, to be retained three minutes. The injection is repeated regularly every two hours, the 1-ounce bottle being filled to the top with distilled water every time it becomes half empty, thus gradually reducing the strength of solution injected.

If any of these methods has been tried and has failed, the following routine treatment should be carried out:—

REPRESSIVE TREATMENT.—

In the most severe cases, with high-grade inflammation, profuse discharge, *ardor urinae*, and chordee, it is very desirable to have the patient go to bed, or at least to be as quiet as possible. A light diet should be ordered, consisting largely of milk, with bread, potatoes, well-boiled rice, and similar plain farinaceous foods. Greasy and highly seasoned articles, coffee and tea, asparagus, tomatoes, salad dressings, acid fruits, and pastry must especially be shunned. **Water** should be taken freely. The **bowels** should be kept rather freely open with small doses of some saline

laxative, repeated as often as necessary. The use of alcohol should be forbidden. Sexual excitement is harmful, and coitus must be positively interdicted. The urethral discharge should be received on a small piece of absorbent cotton held in place by a gonorrhea apron, or similar device, and the **glans** and **prepuce** bathed frequently with **soap and warm water**, both for cleanliness and to avoid balanoposthitis. *Great care must be observed in disposing of the soiled cotton, towels, and all other articles contaminated with the discharge, and the hands should be most carefully washed after each dressing,* as gonorrheal pus, if transferred to the eye in any manner, excites violent inflammation.

Gonorrhea is a local disease, and must be treated largely locally. Internal remedies are of use, however: (1) to render the urine neutral or faintly alkaline, and hence less irritating; (2) to increase the flow of urine; and (3) to allay irritation of the urinary tract by sedative drugs. **Liquor potassæ** meets the first indication, given in doses of 10 minims (0.6 c.c.), freely diluted, 4 to 6 times a day. **Potassium citrate** fills both the first and second indications. The dose is 20 grains (1.3 Gm.) in half a glass of water every two to four hours. With either of these may be combined **sweet spirit of nitre** if there is fever, and **potassium bromide** to lessen nervous excitability. The third indication cannot well be met when the urethritis is very acute. When the severity of the inflammatory symptoms has passed off, however, **cubebs**, **copaiba**, or **sandalwood oil** may be administered with advantage. A satisfactory combination is

the "compound salol capsule" of J. W. White, containing **phenyl salicylate** and **oleoresin of cubebs**, of each, 5 grains (0.3 Gm.); **Para balsam of copaiba**, 10 grains (0.6 Gm.); and **pepsin**, 1 grain (0.06 Gm.). Four to 6 of these capsules are given daily after meals. Capsules of either **cubebs** or **copaiba**, or of the two in combination, may be given, and in the more chronic stages the oil of **sandalwood**, 10 to 20 minims (0.6 to 1.2 c.c.) after each meal, is efficient.

Locally, cleanliness secured by frequent bathing and suitable means to receive the discharge is very desirable. Rubber covers and bulky dressings that macerate the parts are objectionable. A small pledget of antiseptic absorbent cotton, held in place by the prepuce, forms a good dressing. A bag of some thin material, fastened round the loins, is of assistance for additional support. If urination is accompanied by severe pain, great relief will be secured by **immersing the penis in a vessel of water as hot as can be borne comfortably during the act of passing water.**

Urethral injections or irrigations may be employed from the beginning of the disease. Certain points must be kept in mind in this connection: 1. Nothing is to be introduced into the urethra until it has been cleansed by passing urine. 2. The solutions used in the early stages must be exceedingly mild unless abortive treatment is attempted. 3. In the beginning the injection is confined to the first inch or two of the urethra. In high grades of inflammation the solutions should be slightly alkaline, and used as warm as can be borne. Any application that causes severe or prolonged pain or smarting is harmful.

In an acute case the injection may be of **potassium permanganate**, 1:10,000 to 1:5000 in normal salt solution, as in the following formula:—

R *Potassii permanganatis* gr. ss-j (0.03-0.06 Gm.).
Sodii chloridi ʒss (2 Gm.).
Aquæ destillatæ fʒxj (330 c.c.).

M. Sig.: Use four to six times daily, as directed.

Such injections may be carried out by the patient himself, previously instructed in their technique by the surgeon, by means of a blunt-pointed hard-rubber **urethral syringe**, holding at least $\frac{1}{2}$ fluidounce (15 c.c.) or a soft **rubber bulb** with conical point.

A similar solution may be employed to "irrigate" the urethra. To a pint (500 c.c.) of distilled water may be added from $\frac{3}{4}$ to $1\frac{1}{2}$ grains (0.05 to 0.1 Gm.) of **potassium permanganate** and 45 grains (3 Gm.) of **sodium chloride**, the solution warmed, and placed in a fountain-syringe to which a urethral nozzle is attached by rubber tubing. The reservoir should be 2 feet above the pubes. Urine having first been passed, the solution is allowed to run, and the conical nozzle fixed firmly in the meatus. As soon as the anterior urethra is distended the nozzle is removed and the urethra allowed to empty itself. This is repeated until the pint of solution is all used. The solution should be used as warm as can be comfortably borne, and the reservoir elevated 2 or 3 feet if only the anterior urethra is to be irrigated; 4 or 5 feet if also the posterior (the resistance of the compressor urethræ having to be overcome, that the solution may enter and fill the bladder). The irrigations may be given twice, later once, a day, the strength of solution being gradually

increased, according to tolerance, from 1:6000 to 1:2000. No solution stronger than the latter should be allowed to enter the bladder.

When the posterior urethra becomes acutely involved (in about 90 per cent. of cases—Keyes) hand injections restricted to the anterior urethra should be stopped, the treatment being confined to copious irrigations with relatively weak solutions, *e.g.*, 1:10,000 **permanganate** to begin with.

According to some the **organic silver salts** are preferable to **potassium permanganate**, causing a greater reduction in the proportion of subsequent chronic gonorrheas. Keyes, *e.g.*, generally uses 10 per cent. **argyrol**, of which the patient injected 2 drams (8 c.c.) 3 or 4 times daily to be retained ten minutes. After the first few days the treatment is controlled by daily examinations of the discharge for gonococci, the injections being temporarily stopped if evidences of undue irritation appear. If pus shows in the second urine, the anterior urethritis having already been well controlled, **posterior instillations** once or twice a day 1 c.c. (16 minims) of 20 per cent. **argyrol** or 0.5 c.c. (8 minims) of 0.5 per cent. **protargol**, or gentle **posterior irrigations** once a day with 1:2000 **protargol** or 1 per cent. **argyrol** are carried out.

Pain in micturition is best treated by rendering the urine slightly alkaline and by drinking water very freely.

For the relief of painful erections or chordee, the patient should be instructed to empty the bladder just before retiring for the night, and to be awakened by an alarm clock at the end of three or four hours for the

same purpose. He should sleep upon a **hard mattress**, with but light covering, and should avoid lying upon the back. A **hot bath** before retiring will tend markedly to reduce the local congestion. In the daytime hot 5-minute **sitz baths** or a **hot-water bag** to the **perineum** may be ordered. **Bromides** may be given in full doses, and in the more severe cases **chloral hydrate** or **opium**. A **suppository of opium**, **belladonna**, and **monobromated camphor** may be administered at bedtime, for severe pain only. If a painful erection occurs, the patient should arise and apply **cold** locally. Rarely **heat** gives greater relief. **Cold applications** to the **spine** are also sometimes efficient.

Such is the routine treatment during the first few days in the cases with very acute symptoms. When these subside, or when from the beginning the symptoms are subacute the injections may be made somewhat stronger, *e.g.*:—

R *Potassii permanganatis* gr. ss-j (0.03-0.06 Gm.).
Acidi borici ʒj-iss (4-6 Gm.).
Aquæ destillatæ fʒvj (180 c.c.).

M. Sig.: Use as an injection four times a day after urination.

An injection such as the following is useful in a large proportion of cases at this stage:—

R *Hydrargyri chloridi corrosivi* . gr. ¼-½ (0.005-0.01 Gm.).
Zinci phenolsulphonatis gr. xxiv-xxx (1.5-2 Gm.).
Phenolis gr. x-xij (0.6-0.8 Gm.).
Glyceriti boroglycerini (25 per ct.). fʒij (60 c.c.).
Aquæ destillatæ, q. s.
 ad fʒvj (180 c.c.).
 (White.)

This is to be used in the same manner as the previous prescription. It may be diluted at first if it causes

pain. During this period one of the capsules already alluded to should be given.

As the discharge diminishes, the **injections** may be made stronger and more **astringent**. Any of the following may be employed: **Zinc sulphate**, **lead acetate**, or **alum**, 1 to 5 grains (0.06 to 0.3 Gm.) to the ounce (30 c.c.) of water; **glycerite of tannic acid**, 10 to 30 minims (0.6 to 2 c.c.) to the ounce; and **fluidextract of hydrastis**, 5 to 10 minims (0.3 to 0.6 c.c.) to the ounce, using the milder strength first, and gradually increasing the proportion. Various combinations of these drugs may often be made with advantage. The **Brou astringent injection** is an efficacious combination:—

R *Zinci sulphatis* gr. xv (1 Gm.).
Plumbi acetatis gr. xx (1.3 Gm.).
Tincturæ opii,
Tincturæ gambir...āā fʒij (8 c.c.).
Aquæ.....q. s. ad fʒvj (180 c.c.).

M.

When the discharge becomes very scant and watery, the injections being made less often, although the strength may be cautiously increased.

Bubo occurring during gonorrhea should be treated by applications of **tincture of iodine** or **ichthyol**, a **spica bandage**, and **rest**. If suppuration follows, **aspiration** or **incision** is indicated.

Among the last traces of gonorrhea to disappear is a drop of discharge or an undue moisture, observed at the meatus on rising in the morning. Shreds of epithelium may, however, continue in the urine for some time.

After the patient appears to be well, his habits should be guarded for a few weeks, as the discharge may recur from sexual excess, overindul-

gence in alcohol, etc. In some instances in the subsiding stage the discharge seems kept up by excessive treatment. This should be guarded against.

Presumptive evidence of complete cure of gonococcal urethritis is obtainable clinically and positive evidence bacteriologically. Gonococci have probably disappeared when massage of the prostate and vesicles, 3 glasses of beer, and dilatation with a Kollmann dilator or full-size sound at 2-day intervals fail to cause a discharge; when no reinfection has occurred in three years, or where epithelial cells predominate over pus-cells in the discharge and centrifugated urinary sediment. Shreds in the urine do not necessarily imply gonococci. A sparkling urine and absence of discharge and all symptoms for a month indicate a cure. Positive bacteriological evidence involves testing by stain and culture (by a competent bacteriologist) the discharge (if present), the centrifugated urinary sediment, and the urine passed after prostatic and vesicular massage or the secretion obtained from these glands. Cases persisting for two or three months usually have localized areas of infection in some of the urethral follicles or pouches, superficial ulcerations, or even beginning stricture formations, and call for a careful urethral exploration.

Treatment of Chronic Gonorrhea.

—Mild cases of chronic gonorrhea are often favorably influenced by **hygienic measures**, general and local. A generous, **stimulating diet** should be allowed and **outdoor exercise**, gradually increased in amount and severity as tolerance increases, encouraged.

Sexual intercourse should be interdicted as long as gonococci persist in the discharge, but after that may be sparingly indulged in to obviate the local congestion arising from ungratified sexual desire. From the standpoint of internal treatment, free use of **alkaline mineral waters** is generally alone indicated. Inquiry for such predisposing factors as constitutional disorders, marital reinfection, congenital or acquired deformities, and oxaluria or phosphaturia should be made, and their correction, if present, undertaken.

Local treatment may advantageously be begun by daily **injections of astringents**, such as **zinc acetate**. A preparation recommended by Keyes, consisting of **zinc sulphate**, 3 grains (0.2 Gm.) and **dilute lead subacetate solution** (U. S. P.), 3 fluidounces (100 c.c.)—to be shaken up—is of value. Intermissions should be made every few weeks. Where gonococci are still found in the discharge, **injections of protargol** may give better results than the astringent injections. In cases with only a slight discharge, **irrigations with 1:4000** (later strengthened) **potassium permanganate solution** may be substituted for the injections.

Where results from these procedures are insufficient, the urethra should be examined with a bulbous bougie (bougie à boule) or electric urethroscope. The former suffices to detect all parietal thickenings, constrictions, granular areas, and papillomas of the anterior urethra, and where such are found establishes the advisability of treatment by **gradual urethral dilatation**. The latter has for its object to encourage reabsorption of inflammatory exudates and to

empty distended urethral glands, and is performed at first with conical **steel sounds** (unless the urethral caliber is already about 21 F.), later with the **Kollmann** or **Oberländer urethral dilators**. The use of the sounds, to be passed twice weekly, is described under Stricture of the Urethra, in this article. Their passage should be preceded by ingestion of **hexamethylenamine** and followed by **intravesical irrigation** with 1:4000 **potassium permanganate**. When the largest size sound that will enter the meatus is reached the **Kollmann dilator**—well lubricated and sterile—should be substituted. By its use rapid progress can frequently be made, without causing marked bleeding or pain. **Dilatation of the posterior urethra** is only in a certain proportion of cases required; for its practice a curved anteroposterior Kollmann or other dilator is necessary. Dilatation is of chief value when the urine is already nearly free of pus, and is contraindicated where the pus still shows gonococci.

With dilatation may be combined with advantage **massage of the prostate and seminal vesicles** (see Disorders of the Prostate and Disorders of the Seminal Vesicles, in this article). Where these organs are considerably involved, indeed, massage should be started practically from the beginning of treatment. When massage is impracticable or proves deleterious, daily **rectal douching with hot normal saline solution** (120° F.) from a ½-gallon receptacle hung at an altitude of two feet, through a **double-current rectal tube** or **psychrophore**, may be substituted. An intermission of a few days should be allowed from time to time, the ob-

ject being to apply **heat to the prostate** while avoiding irritation of the rectum.

Infiltrations of the urethral glands and follicles, though generally cured by the **dilatation** treatment, are sometimes refractory. They are best treated through the urthroscope, electrically illuminated, a 5 or 10 per cent. solution of **silver nitrate** being **applied** directly to the affected areas, once or twice weekly, after these have been wiped dry of secretions. Suppurating follicles may be destroyed with the **electrocautery**; thickened glands, slit open with a fine **bistoury**, and any polyps found, **removed** with **forceps**, **cautery**, or **snare**. Granular or eroded areas should be treated with 1 or 2 per cent. **silver nitrate**.

Good results in acute and chronic gonorrheal urethritis reported from a **polyvalent vaccine** made from a large number of samples of the gonococcus, together with other aerobic and anaerobic germs. The vaccine is injected in the buttocks every other day, beginning with 100 and increasing to 400 millions. **Urethral irrigations with mercury oxycyanide** are begun after the fourth or fifth vaccine injection. By this method a cure was effected in fifteen to twenty-five days in 95 per cent. of about 300 cases. G. Baril (Bull. de l'Acad. de méd., Aug. 13, 1918).

Acridavine found valuable in gonorrhea. In anterior cases, 3 c.c. (48 minims) of a 1:1000 solution were injected, to be retained five minutes. In posterior cases, 15 to 30 c.c. (½ to 1 ounce) were injected through into the bladder, retained in the urethra for five minutes and in the bladder till the next voiding. Injections were given twice a day. Davis and Harrel (Jour. of Urol., Aug., 1918).

GNORRHEA IN WOMEN.—

This affects, in the order of frequency, the **urethra**, **cervix**, **vulva**, and **vagina**.

Urethra.—In the incubation period, changes in the external meatus, and appearance of the discharge, gonorrhea of the urethra in women is identical with that of men. There is frequent urination, attended with a scalding sensation, and the discharge may irritate the parts contiguous to the meatus. The bladder is apt to become affected, owing to the very short urethra, in which event the frequency of urination and tenesmus may be extreme.

TREATMENT.—In severe cases much benefit will be obtained by putting the patient at absolute rest. Frequent bathing of the parts with water as hot as can be borne, to which a little sodium bicarbonate or borax has been added, is of assistance. Internally, potassium citrate or bicarbonate, or even liquor potassæ, is indicated to give a faint alkaline reaction to the urine, which should be tested frequently and the dose of the drug regulated according to the effect. Water should be taken freely. The urethra should be irrigated with some form of reflux catheter, or with a Nélaton catheter of small size permitting return flow round the instrument. The formulæ given under the treatment of gonorrhea in the male should be employed, and the patient should invariably urinate before the irrigation. The solution should be very weak at first, then made stronger as the acuteness of the symptoms subsides.

Vagina and Vulva.—Gonococcal infection of the vagina and vulva, including Bartholin's glands, are considered in the article on VAGINA AND VULVA, DISEASES OF, in this volume.

Cervix.—Gonorrhea of the cervix is the most serious form of the dis-

case, inasmuch as it may extend upward, involving the uterus, tubes, ovaries, and peritoneum. Nor is the danger over when the acute symptoms have subsided. The disease may remain latent in the cervix for a long time, ready to assume fresh virulence and spread to other structures under favorable conditions.

SYMPTOMS.—These are variable and by no means characteristic. There is but a moderate amount of discharge, which might easily escape notice, especially in those with a previous leucorrhea. In the more severe cases there may be a feeling of fullness or weight in the pelvis, increased by exercise. Menstruation is apt to be more frequent and profuse than normal, and may be unusually painful. If the cervix be examined, it will be found swollen and of a deeper red than normal, with the os somewhat everted, or pouting. A tenacious secretion of mucus will be seen issuing from the os and bathing the adjacent parts. The mucous membrane around the os may have exfoliated, leaving an eroded or ulcerated surface. Such conditions may persist indefinitely.

TREATMENT.—In acute cervical involvement, hot vaginal irrigations with 2 per cent. boric acid solution, $\frac{1}{2}$ to 1 per cent. lysol, or 1:5000 or 1:10,000 mercury bichloride are of value, though some object to them on the ground that the protective acid vaginal secretion is thus washed away. When the acuteness of the process is subsiding an attempt may be made to prevent its further ascension by cleansing the cervix and os carefully with the aid of a bivalve speculum, swabbing with 1:2000 mercury bichloride, dilating the cervix,

and **destroying the mucous membrane by curetment or pure phenol or silver nitrate**. Such active measures should, however, be undertaken only by those specially experienced, as there is danger of infecting the endometrium. A milder procedure likewise of value consists in applying daily and later, on alternate days, the vaginal cervix and cervical canal—especially to any erosions noted—**tincture of iodine, Lugol's solution, a 10 per cent. or stronger solution of argyrol, a 2 to 10 per cent. protargol solution, or a 3 to 5 per cent. solution of silver nitrate**. Where the tissues are boggy and chronically hyperemic a 10 per cent. **zinc sulphate** solution may be instilled. The applications may well be followed by the insertion of a **dry tampon** dusted with **aristol** or **iodoform** or of a 10 per cent. **boroglycerin** or **ichthyol and glycerin tampon**. Between office treatments, home douching with the **mild antiseptic solutions (boric acid, etc.)** above mentioned may be prescribed, with or without **ichthyol suppositories**.

In gonorrhea of the uterine cavity, similar procedures may be employed, the uterus being swabbed out with **silver nitrate solution** or **tincture of iodine**, followed by the insertion of **iodoform gauze tampons**. The treatment of gonococcal endometritis, salpingitis, and ovaritis appertains to the field of the gynecologist rather than that of the genitourinary specialist, and for information on these subjects the reader is referred to the articles on **ENDOMETRITIS**, volume iv, and **OVARIES AND FALLOPIAN TUBES, DISEASES OF**, volume vii.

PERIURETHRITIS AND URETHRAL FISTULA.—Periurethritis is usually a complication of gonorrhea or

stricture, but may also follow trauma of the urethra, affects the anterior urethra, is often due to outward rupture of an abscessed urethral gland, and begins as a hard, somewhat sensitive nodule from which, especially in periurethritis complicating stricture or trauma, invasion of adjoining tissues takes place, with ultimate discharge through the skin. In stricture cases it arises from masses of cicatricial tissue, generally behind the stricture, a febrile reaction taking place when suppuration begins, may so press on the urethra as to cause retention of urine, and may discharge into the urethra or invade the subcutaneous tissues of the perineum and even of the lower limbs and inguinal regions, causing one or more fistulae. Urinary infiltration and gangrene are possible, and often fatal, complications.

Urethrorectal fistula is an uncommon condition, usually involving the prostatic urethra, and due to trauma—sometimes operative—prostatic abscess, malignant disease, or tuberculosis.

Treatment.—Acute periurethritis should be treated by rest of the part and **wet or ichthyol dressings**. When free suppuration develops, the abscess should be **incised**, either from within through a urethroscope or externally, according to indications. In stricture cases the use of **steel sounds** benefits simple periurethritis, but where abscess formation occurs **drainage** through a median incision in the perineum is indicated, together with **incision** of the stricture itself. Whenever urinary fistulae are formed, their healing is distinctly favored by **injections** into their urethral end, made with a fine pipette, through a wire urethral speculum, of a strong (5 to 25 per cent.) solution of **hydrogen dioxide in ether**; such **dilatation** of the **stricture** as will render easy the flow of urine through the normal channel is, furthermore, essential. Where infiltration of urine takes place through the subcutaneous tissues, free **incisions** must at once be made and all dead tissue removed.

Urethrorectal fistulae of inflammatory or traumatic origin often close spontaneously. Where this does not occur, closure can often be effected by simple **suturing** or more complex surgical procedures. In

fistulae due to cancer or tuberculosis, however, success is not to be expected.

COWPERITIS.—Inflammation of Cowper's glands, two small structures of cherry-stone size situated in the muscular tissue between the layers of the triangular ligament in the male, immediately behind the bulb of the urethra, occurs as a complication of gonorrhea, and is manifested as a small tender mass just to one side of the median line in the perineum. The condition is analogous to periurethritis, and is unavoidably liable to confusion with inflammation of other smaller glands surrounding the perineal urethra. The resulting abscess may extend some distance under the deep fascia before rupturing the latter and discharging through the skin.

Treatment.—The treatment is similar to that of periurethritis. (See above.)

NON-GONORRHEAL URETHRITIS.

—This may be due to one of a large variety of causes, such as traumatism, overstrong injections, permanent catheterization, foreign bodies, internal use of irritant diuretics, marked acidity of the urine or oxaluria, and, in women, the contact of irritating uterine or vaginal discharges. It may also accompany gout or syphilis, or be of herpetic, eczematous, tuberculous, or papillomatous nature. Previous gonorrhea or sexual excesses predispose to simple urethritis.

Symptoms.—Traumatic urethritis is of varying severity, according to the degree of irritation produced. Pain often appears immediately, and a mucous or purulent discharge, with or without blood, appears in twenty-four hours. Urethritis *ab ingestis* is usually mild, and may be excited by alcohol, cantharides, arsenic, turpentine, etc. Gouty urethritis begins in the posterior urethra, causing frequent painful urination and a scanty discharge. Syphilitic urethritis may be manifest as a chancre of the urethra, as a mild urethral inflammation accompanying the secondary eruptions, or as a gummatous ulceration. Herpetic urethritis represents an extension of external herpes of the genitals, and may cause a mild dysuria and discharge. In tuberculous urethritis ulceration usually develops near the neck of the bladder, causing marked irritability of the

latter, and later persistent cystitis, with great pain at one point when a bougie is passed and a bloody, though slight, discharge. Papillomatous urethritis is described under *Tumors of the Urethra*, q. v.

Diagnosis.—This is made by inquiry and examination for one of the above-mentioned factors, as well as by study of the discharge. Simple urethritis is differentiated from gonococcal urethritis by the absence of gonococci and by the usually mild symptoms, swelling of the meatus being slight or absent, micturition and erection painless, and the discharge often only mucopurulent. Bacteria isolated from the discharge in simple urethritis are generally those found at times in the normal urethra. Gouty and syphilitic urethritides are recognized from coexisting phenomena of these diseases; chancre in the urethra is usually palpable from the exterior as a hard lump. Herpetic and eczematous urethritides are, in many instances, diagnosed by the presence of similar extraurethral lesions. In tuberculous urethritis evidence of the specific process responsible may at times be found in the discharge.

Treatment.—The cause of the affection should, if possible, be removed. In simple urethritis the local treatment is that of a declining or chronic gonococcal urethritis (q. v.); the organic silver-salts are, however, without value in this form (Keyes). Mild astringent injections are of use. Internally, such drugs as sodium bromide, opium and belladonna may be prescribed if indicated; likewise diluent drinks and a saline purgative. Heat applied to the perineum is likely to bring some relief. In gouty and syphilitic urethritis, the customary constitutional treatment should be instituted; daily flushing of the urethra with 1 to 8000 silver-nitrate solution is sometimes indicated and beneficial. Eczematous urethritis is treated with arsenic and alkalis internally and cold or iced water irrigations locally. Herpetic urethritis requires astringent injections and tuberculous disease is treated much as vesical tuberculosis. (See Tuberculosis of the Bladder, in this article.)

STRICTURE OF THE URETHRA.—The normal urethra is dilatable to a certain caliber, depending

upon the circumstances of the flaccid penis. Any condition interfering with this normal dilatibility is called a stricture.

VARIETIES.—Stricture may result from inflammatory changes such as accompany acute urethritis. This condition is temporary and subsides under appropriate treatment. On the other hand it may be due to muscular spasm, usually of the compressor urethræ, itself the result of the irritation caused by an acute urethritis or a urethral erosion, either alone or existing behind a stricture, or, more rarely, of reflex irritation from hemorrhoids, anal fissure, etc. Finally, stricture may result from the organization and contraction of lymph following gonorrhea or other urethral injury. The latter type is called an *organic* or *true stricture*.

Congenital stricture of the urethra is rarely observed. The diagnosis and treatment are similar to those of organic stricture.

SYMPTOMS.—These commonly include a gleet discharge; some increase in the frequency of urination, and dribbling at the conclusion of the act, which is apt to require a longer time than normal and may require some voluntary effort. The stream may be much smaller than normal, and may be forked, twisted, or otherwise altered. If one or more of these signs be present in a man who has had gonorrhea or other serious urethral lesion, stricture may reasonably be looked for. Temporary or persistent complete retention of urine may result from the congestion of the urethra behind a stricture attendant upon an alcoholic excess, a heavy meal, or a chilling of the lower extremities. Other manifestations of

stricture include hematuria, abnormalities of the sexual function, and pains due to accompanying prostatitis or cystitis.

DIAGNOSIS.—For exploration of the urethra, the acorn-headed bougie (*bougie à boule*) should be employed.

The following approximate relationship has been shown to exist between the circumference of the flaccid penis at the middle of the pendulous portion and the caliber of the urethra:—

Circumference of Penis.	Caliber of Urethra.
3 inches.	26-28 millimeters.
3¼ inches.	28-30 millimeters.
3½ inches.	30-32 millimeters.
3¾ inches.	32-34 millimeters.
4 inches.	34-36 millimeters.

A suitable lubricant for urethral instruments is liquid vaselin or liquid albolene containing 2 per cent. of phenol, or a 25 per cent. solution of boroglyceride containing the same amount of phenol. Lubricants soluble in water, such as boroglyceride and glycerin, are preferable in that the sterilization of instruments covered with them requires only ten minutes' boiling, as against one-half hour in the case of instruments covered with oily lubricants (Albarran).

If a *bougie à boule* of appropriate size can be passed into the bladder and withdrawn without being arrested at any point, the caliber of the urethra must be considered normal. If a stricture is present the instrument will be arrested at the contracted area if it is distinctly smaller than the bulb of the bougie, or, if the caliber very nearly corresponds, the stricture may not be detected until the instrument is withdrawn, the abrupt shoulder being especially designed to detect contractions when

passing in this direction. The examination should be begun with an instrument nearly equal to the normal caliber of the urethra as indicated in the above table, and if it meets an obstruction, smaller and smaller sizes tried until one is found that will enter the bladder. Strictures may be met with so small that nothing larger than a filiform bougie will pass, and occasionally even this cannot be introduced (impassable stricture).

A perceptible grasping of the sound by the resilient tissues of the stricture as it is withdrawn indicates an organic stricture rather than urethral spasm or chronic inflammation.

In all urethral instrumentation, the greatest gentleness should be used.

ETIOLOGY.—Nothing need here be added to what has already been said of the first two varieties of stricture. Organic stricture is usually the sequel of gonorrhea. The gonococci tend to penetrate the mucous membrane and to develop in its deeper layers, thus establishing also a peri-urethritis. The severity of the inflammation at one or more points causes exfoliation of the epithelium, the urine therefore tending to infiltrate the tissues. To prevent this nature surrounds the vulnerable point with lymph and later scar-tissue, which gradually contracts, interfering with the dilatability of the urethra. The contraction is very slow; months and perhaps years may pass before the patient is aware of any distinct trouble in urination. In most cases (67 per cent.—Thompson) gonorrheal stricture occurs in the bulbo-membranous part of the urethra, another common site being the first $2\frac{1}{2}$ inches from the meatus.

The next most frequent cause of stricture is rupture of the urethra. The resulting changes are very similar to those in inflammatory strictures.

TREATMENT.—Strictures are treated by (1) dilatation or (2) cutting [(a) internal urethrotomy; (b) external urethrotomy]. The various other methods sometimes described are applicable to but very few cases or are to be entirely condemned. All of the following procedures must be carried out with the most rigid attention to antisepsis:—

Dilatation.—This method is to be chosen in every case in which it is applicable. It is unsuitable in: 1. Impassable strictures. 2. Those below No. 10 or 12 of the French scale, as it is unsafe to pass bougies below this size. 3. Strictures of the meatus and first $1\frac{1}{2}$ inches of the urethra, as experience has demonstrated that these will not yield to dilatation. 4. Strictures of the pendulous urethra, usually (if recent and of large caliber, gradual dilatation should be tried). 5. Traumatic strictures, as a rule, are not dilatable and require division.

Preparation for urethral dilatation should preferably include the giving of **hexamethylenamine** in 15-grain (1 Gm.) daily dosage for one or two days before the procedure, as well as by **washing the end of the penis** with soap and water and **irrigation of the meatus** with 1:1000 silver nitrate solution.

To prepare for gradual dilatation in cases of stricture below 10 or 12 French, a **whalebone filiform** should be introduced, or, if possible, two or more, and retained from twenty-four to forty-eight hours. This will soften and enlarge the caliber of the stric-

ture. Or, having passed a filiform into the bladder, a **Gouley tunneled catheter** may be introduced over this as a guide and retained. The passage of a filiform in difficult cases is facilitated by rotation after slight withdrawal when the instrument catches, by the use of a **bent or twisted filiform**, and by filling the urethra with filiforms, one of which will finally engage after all lacunæ and false passages have been occupied by others. As soon as either of these methods has secured sufficient enlargement, **gradual dilatation** should be begun. This treatment will usually be applied to strictures situated in the bulbous or membranous urethra, excepting those of traumatic origin.

In cases of sudden retention of urine following exposure or table excesses, refractory to instrumentation, relaxation may often be obtained with repeated **hot sitz baths** or a **prolonged hot full bath**. If this fails, **aspiration** of the bladder (see Retention of Urine, in this article) or **external urethrotomy** will be required.

Gradual dilatation is advised in all strictures of the deep urethra if a No. 12 French or larger instrument can be passed. It should also be tried in recent soft, large strictures of the pendulous urethra, excepting those of the first inch and a half of the urethra. It is carried out as follows: Suppose a No. 16 French *bougie à boule* has demonstrated a stricture. A No. 17 or 18 **metal** urethral conical **sound** should be passed and allowed to remain a few moments, after which a 19 or 20 may be introduced. The next treatment should be three to five days later, depending upon the case, at which time probably an 18, 20, and 22 *bougie* may be passed, and

so on, increasing one or two sizes at each visit, until the normal caliber has been reached. Occasionally a stricture is so dense and inelastic that the same sizes must be used at 2 or more successive sittings before a larger size will pass. In strictures smaller than 15 F. but not requiring the use of a filiform, the substitution of **woven conical bougies** for metallic instruments is advised owing to greater danger of making a false passage with the latter. The **Kollmann dilator** may be used where the patient objects to having a congenitally narrow meatus cut or where the stricture, already dilated to correspond with the meatus, undergoes rapid recontraction. The general rule should be to "coax" the stricture rather than to employ force. After the full caliber has been obtained a bougie of the proper size should be passed at gradually increasing intervals for two to three years, and, if any tendency to recontract is observed, throughout the patient's life.

Urethrotomy.—Gradual dilatation having failed, or being impossible, some form of cutting operation will be necessary.

Internal Urethrotomy.—Strictures of the meatus and first $1\frac{1}{2}$ inches of the urethra may be divided either with a convex, blunt-pointed tenotome or with one of the various forms of urethrotomes. Strictures situated $1\frac{1}{2}$ to $4\frac{1}{2}$ inches from the meatus may be divided with a urethrotome, the dilating instrument being best for this purpose. If the caliber is below 15 French, it may be necessary to use a urethrotome of the Maisonneuve variety to prepare for the dilating urethrotome.

The division should be made in the roof of the urethra. After the stricture has been cut a *bougie à boule* of appropriate size should be passed to be sure that the

proper caliber has been obtained, and, if not, a second division made.

A full-sized, freshly boiled, soft-rubber catheter should be passed and retained for seventy-two hours, a 1:2000 solution of **protargol** being passed through as it is withdrawn. Later full-sized **metal bougies** should be passed as directed under gradual dilatation, and again at longer intervals for some years.

External Urethrotomy: **A. With a Guide—Syme's Operation.**—This is usually required at the deep urethra, in which situation it is called **external perineal urethrotomy**. It is required in strictures of the bulbomembranous and membranous urethra that cannot be cured by gradual dilatation.

A **grooved staff** is passed into the bladder, the urethra exposed by an incision in the middle line of the perineum and the stricture divided upon the staff. If the staff will not pass the obstruction the urethra is opened on the tip of the instrument just anterior to the stricture. By carefully holding the divided edges of the urethra apart a filiform may be passed which will act as a guide in dividing the contracted portion. Or, a filiform may be introduced and over it a tunnelled catheter staff.

B. Without a Guide—Perineal Section.—Cases of impassable stricture of the deep urethra require this procedure. An instrument is passed as far as possible, and the urethra opened upon its tip through a median perineal incision. The strictured portion is then probed and divided, carefully keeping in the line of the urethra. A good light is essential. Occasionally the strictured canal cannot be located, when either **suprapubic cystotomy** and **retrograde catheterization** or extension of the operation so as to open the urethra at the apex of the prostate will become necessary. The operation should be undertaken only by those who have had considerable experience in this line of work.

After each of these operations a rubber catheter may be passed through the urethra into the bladder and retained for several days. The perineal wound is packed gently with gauze. After the catheter is removed **urethral bougies**

should be passed, as directed after Internal Urethrotomy.

URETHRAL, URINARY, OR CATHETER FEVER.—**Symptoms and Etiology.**—Not infrequently a patient will have a chilly sensation or a slight chill after an instrument has been passed into the bladder, especially for the first time (*urethral shock*). This may be accompanied by faintness, nausea, and weak pulse, but is not followed by a hot stage or sweat, and there is no elevation of temperature. The phenomenon is supposed to be of reflex origin, and does not constitute urethral fever. It is of no significance and requires no treatment.

In rare instances after instrumentation of or operation on the urethra the patient is seized with a severe chill, especially at the time of the next urination, followed by fever and sweat. There may be but a single paroxysm, in which case the patient's condition returns to normal in from a few to twenty-four hours. In other cases the chill, fever, and sweat recur at irregular intervals. The former is probably due to the absorption of a minute dose of toxic material through a fresh wound of the urethra caused by the instrumentation. The latter is undoubtedly a genuine septic infection, the micro-organisms or their toxins being absorbed through the urethral lesion and producing a septicemia or pyemia of the gravest type.

Patients who have suffered long with stricture of the urethra and whose kidneys have become infected secondarily seem especially predisposed to this accident. According to some, the occurrence of the urinary chill is entirely limited to cases with pre-existing disease of the kidneys, generally a pyelonephritis, and the chill is due to acute renal congestion, itself caused by absorption of bacteria from the injured urethra. Peculiarities of the condition are that its incidence often has no relation to the severity of the instrumentation carried out, though manifestly increasing with its depth, i.e., distance from the meatus. The extreme gravity of the severer forms of urethral fever should constantly be borne in mind, and every effort made to prevent its occurrence.

Acute urinary septicemia may follow

urethral fever, and is due to absorption through the kidneys of toxic products from retained, infected urine. A focal suppurative nephritis is the pathological process induced, and the symptoms consist of irregular, high fever, with or without recurrent chills, and renal tenderness and pain.

Chronic urinary septicemia results from prolonged toxic urinary absorption, and is characterized by low, irregular fever, anorexia, constipation, a tongue bright red laterally, but often coated; dryness of the mouth; a drawn, sallow or pasty face; some polyuria, loss of weight, and drowsiness, merging into a uremic state. Renal suppuration is always in some degree associated.

Treatment.—The treatment of urethral fever should be prophylactic. The most rigid antisepsis and gentleness in urethral instrumentation and the internal use of one of the **urinary antiseptics** will usually prevent it. The meatus, glans, and prepuce should be cleansed with soap and water, followed by **potassium permanganate** or **boric acid solution**, before catheterization or other urethral instrumentation. Operations should be preceded by the use of **hexamethylenamine**, $7\frac{1}{2}$ grains (0.5 Gm.) 3 times a day for two days, and by copious drinking of **diuretic mineral waters**, and should be followed by irrigation of the urethra and bladder, proper provision being made for drainage.

If the disease has already become established, **boric acid** and **phenyl salicylate (salol)**, $7\frac{1}{2}$ to 10 grains of either, may be administered 4 times a day, or, better, **hexamethylenamine** employed in the dose already mentioned. The urethra and bladder should be thoroughly irrigated at frequent intervals with **potassium permanganate**, 1 in 5000 to 1 in 2000; **silver nitrate**, 1 in 8000, or **boric acid** or **normal saline solution**.

Constitutional treatment is also important. Quiet rest in bed should be imposed. The patient will require a **nourishing diet**. Three pints (1500 c.c.) of milk per day will not be too much, and 3 to 6 eggs should be given, either with the milk or separately. **Stimulants** must be administered freely. **Whisky** or **brandy** may be given, the amount being determined by

the effect. Full doses of **strychnine** should be given, and **digitalis** may be added if there is evidence of enfeebled circulation. **Diuresis**, **saline catharsis**, and **hot foot-baths** are indicated. In severe cases, **hot-air baths** or the **hot pack**, and **cupping** in the lumbar regions, may be appropriate and beneficial.

Where toxic absorption seems progressive in spite of the above measures, a **perineal urethrotomy** or **suprapubic cystotomy** may become necessary to improve drainage.

In acute or chronic urinary septicemia similar measures are indicated, efforts being likewise made to relieve retention of purulent urine, as by **catheterization**, **urethrotomy**, or **cystotomy**, and to overcome renal suppuration, if necessary, by **nephrotomy**.

CHANCROID.—Definition.—

Chancroid, or soft chancre, is a specific, local venereal lesion due to the streptobacillus of Dugrey.

Symptoms.—After an incubation period of from one to five days—usually three to five—a pustule develops which rapidly enlarges and in a few days ruptures, forming an ulcer. The latter is generally round and presents sharply defined, perpendicular margins, with a deeply set, grayish yellow, soft, and irregular base. An abundant, purulent, foul discharge is liberated, which is autoinoculable, inducing additional lesions as it passes over adjacent tissues. The lesions are surrounded by inflammatory areolæ, are painful when rapidly enlarging, and bleed easily. A chancroid is seldom indurated unless already cauterized, associated with the hard chancre of syphilis, situated at the meatus or in the post-coronal sulcus, or complicating phimosis. In the male the commonest site of chancroid is the coronary sulcus; in women, the introitus. The lesions are usually multiple, and may extend not only

over the external genitals, but also over the perineum and onto the legs and abdomen. Untreated chancroid lesions free of complications begin to heal in three or four weeks. No constitutional symptoms accompany chancroids when uncomplicated.

Etiology.—Chancroid is almost always transmitted by sexual contact, although instances of infection from the soiled hand are on record. An abrasion, albeit slight, is necessary for infection with it, unless contact be very prolonged. Uncleanly habits are an important predisposing factor, the use of soap and water upon exposure being almost certainly prophylactic.

The causative organism, discovered by Ducrey in 1889, is a dumb-bell shaped bacillus occurring both extra- and intra- cellularly, and arranged typically in parallel chains. It is negative to Gram's test-stain, but stains easily with methylene blue, fuchsin, etc. As it excites no systemic reaction or immunity it can be repeatedly inoculated in the skin surface. It loses its virulence when heated to 105° F.

Diagnosis.—This is ordinarily made clinically, the history of recent exposure, and the multiple, discharging ulcers, with or without bubo, being sufficient. Differentiation from syphilitic chancre is especially important, and is complicated by the fact that a positive diagnosis of chancroid does not exclude the possibility of co-existing syphilitic infection in the chancroidal lesion itself. Such co-existing infection may often be detected through examination of the discharge for the spirocheta. (For further discussion see article on *SYPHILIS*, in this volume). The presence of chan-

croid is, on the other hand, best definitely ascertained—examination for the bacillus of Ducrey being uncertain owing to the paucity of these organisms and the many pyogenic and other bacteria present—by auto-inoculation. This is carried out by placing under the skin on the outer aspect of the thigh, by means of a pin or bistoury, a little pus from the suspected ulcer, the point being inserted deeply enough to draw the least possible amount of blood. If a typical chancroidal lesion appears on the third day at this point, the test is positive; in case of doubt, the secretions of the new lesion may with advantage be examined for the bacillus of Ducrey.

Complications.—The commonest complication of chancroid is inguinal adenitis (bubo), which is met with in about one-third of all cases. It may be uni- or bi- lateral, and, when the latter, is generally more marked on the side of the primary ulcer. The involvement may be a simple inflammation without suppuration, soon terminating in resolution, or may extend to a periadenitis, with massive adhesions of glands and surrounding tissues, usually followed by suppuration. The abscess, after rupturing, may heal like other abscesses or may form a chancroid ulcer, from which autoinoculation may take place (virulent bubo).

Other possible complications include the "mixed sore" already referred to, inflammatory phimosis due to chancroidal disease beneath a long prepuce, paraphimosis, balanoposthitis, buttonholing and destruction of the preputial frenum, lymphangitis, rapidly progressive and destructive ulceration (phagedena), and gan-

grene. Phagedena from chancroidal infection is less frequent than from syphilitic lesions.

Treatment.—All chancroidal lesions not more than a week old, whether minute or large, should be **cauterized** with pure **nitric acid**. Each lesion, with the surrounding skin, is first washed with **hydrogen dioxide**. **Petrolatum** is then applied round the lesions, which are next carefully dried with strips of blotting-paper, anesthetized with pure **phenol** or 10 per cent. **cocaine** solution, and **cauterized**, after the whitened surface has been again dried, with **nitric acid** on a glass rod until the open areas are wholly stained brown or yellow. The lesions are then again washed with **hydrogen dioxide** and **dressed with calomel**, or, even better, **iodoform**. Where cauterization is refused by the patient or fails, or the lesions are over a week old, the treatment is limited to **washing** very frequently with **hydrogen dioxide** solution diluted one-half (this may be preceded by **soaking the penis in hot saline solution**), drying with cotton, and dusting with **iodoform**, **nosophen**, or **calomel**. When granulation begins the lesions may be dressed with 1 part of ointment of **mercury nitrate** to 7 of **petrolatum**; cauterization with the **silver-nitrate stick** or pure **phenol** may be practised every few days, or **red or black wash** may be continuously applied.

In the prevention of complications, protection of external lesions from friction by means of a **large cotton dressing** is of importance. To reduce the chances of **bubo**, the patient should stay as **quiet** as possible. As soon as **bubo** appears, he should be put to bed and a **hot-water bag** or

ichthyol dressing applied. Pressure through a **spica bandage** of the groin may be of value. If suppuration occurs, **evacuation** should be effected through one or more **stab incisions**, the cavity washed out with **hydrogen dioxide** followed by **mercury bichloride solution**, a warm 10 per cent. **iodoform ointment** injected, and **iodoform** or a **wet dressing** applied externally. Injections of **iodoform ointment** should be made every three days until pus formation has been arrested. Where chancroidal ulceration takes place in spite of treatment the lesions should be **cauterized** and dealt with like the primary sores, any badly diseased tissues being, moreover, cut away. Persisting hard masses of inguinal glands should after a time be **excised**, even if suppuration has not occurred.

Where **phimosis** gives trouble, the **prepuce** should be **slit up** (circumcision being often a failure at the time), the cut margins touched with pure **phenol**, and the ulcers thus exposed **cauterized**.

Phagedena is met by the internal administration of **quinine**, **iron**, and **milk punch**, and by thorough local use of the **actual cautery**, **nitric acid**, or **bromine**—under general anesthesia if necessary—followed by **iodoform** and **wet dressings**, or, better, **continuous antiseptic irrigation**.

TUMORS OF THE URETHRA.—The benign tumors of the urethra include **papilloma**, **fibroma**, **cysts**, and **angioma**; the malignant, **carcinoma**, and **sarcoma**. In the male, tumors seldom occur unless **gonorrhea** has preceded.

Papilloma is usually a multiple tumor, occurs nearly always on the floor of the urethra close to the meatus, and is analogous to the **papilloma** (venereal wart) often met with on the external genital organs. The diagnosis of the deeper lesions

is made with the urethroscope or by means of an acorn-headed bougie, the small warty outgrowths being felt with the fingers from outside the penis as the head of the bougie is being withdrawn. The papillomata occurring, as is nearly always the case, in chronic gonorrhea may be associated with a persistent urethral discharge (**papillomatous urethritis**). Urethral papillomata readily bleed.

Treatment.—**Destruction** of the growths through the urethroscope may be effected by vigorous **scraping** with cotton on a probe, and with the **urethral curette**, hemorrhage being arrested by **pressure**. To prevent recurrence Keyes recommends the application of a saturated alcoholic solution of **salicylic acid** to the bases of the growths twice weekly until their tendency to return is checked.

Fibroma is met with singly, generally in the bulbous urethra, usually associated with a myomatous or myxomatous component, and is very rare. Polyps of the prostatic urethra are apt to cause hemorrhage from the urethra, with or without difficulty in urination or catheterization. The treatment is **operative**, the growth being removed through a **median perineal incision**.

Cysts of the urethral glands occur in chronic gonorrhea.

Angioma is met with chiefly in women in the form of the so-called **urethral caruncle**, near the external meatus. Frequent painful urination and marked local sensitiveness are characteristic of this lesion, which may be **excised** or destroyed with the **actual cautery**.

Carcinoma of the urethra is uncommon and is almost invariably secondary to cancer of the prostate or penis. The lesion is typically hard and wart-like, sometimes resembling leucoplakia, and is treated by **excision** or exposure to **radium**. Recurrence usually follows.

Sarcoma of the urethra is generally met with in the female sex. The treatment is **excision**.

DISEASES OF THE PROSTATE.

ANOMALIES.—These are rare examples of defective development and occur only in conjunction with extensive malformations of the adjacent urinary and genital organs.

INJURIES OF THE PROSTATE.

Wounds of the prostate complicating injuries to the perineum or rectum are accompanied by the symptoms attending lacerated wounds in general. If the urethra is lacerated also, there will probably be retention of urine or extravasation at the point of injury; or, retention may result from swelling of the gland, simply, without injury of the urethra. Infection of the wound will give rise to a diffuse inflammation, or, what is more serious, to phlebitis of the prostatic plexus, which is prone to cause septicemia or pyemia. The extravasation of urine is apt to involve either the perineum or the prevesical space; in the latter case, if not checked by prompt incision and drainage, it will involve the areolar tissue of the abdomen, thighs, penis, and scrotum.

Wounds of the prostate caused by the unskillful use of catheters will be followed by hemorrhage, probably by retention, and in some instances by inflammation of the gland.

The constitutional symptoms depend upon whether profuse hemorrhage has occurred, or local inflammation or serious infection of the wound taken place. Infectious phlebitis is very apt to cause chills and pronounced constitutional symptoms.

Etiology.—Wounds of the prostate are rare, owing to the protected situation of the gland. Lacerated wounds of the perineum or rectum by a pointed object may involve the prostate. It may rarely be injured in extensive fracture of the pelvic bones. It is wounded in puncturing the bladder with a trocar from the perineum, or even from the rectum. When enlarged, it has been wounded by injudicious attempts to pass a metal instrument through the urethra into the bladder. It is always cut in performing perineal cystotomy.

Treatment.—The patient should be confined to bed. Perineal wounds involving the prostate require the same treatment as do lacerated wounds elsewhere. Foreign bodies should be removed, bleeding well controlled, the surfaces cleansed, and drainage provided for. Frequently a tampon of iodoform gauze will serve both to arrest the bleeding and afford drainage. If the prostatic wound

be extensive, it is advisable to introduce a catheter into the bladder through the urethra and leave it in. If the urethra or neck of the bladder has been opened by the accident, the **retained catheter** is particularly important. If one cannot introduce the catheter on account of urethral laceration, perineal section should be done. The catheter may then be placed through the perineal wound, or, preferably, through the entire urethra. If bleeding has occurred backward into the bladder, copious irrigations of **warm, boric acid solution** through the bladder should be employed. If the catheter becomes occluded by clots, they may be dislodged by making suction with the syringe or by injecting a little **boric acid solution**.

Wounds of the prostate caused by fracture of the pelvis are treated upon general principles. If the urethra be lacerated a **permanent catheter** must be introduced, cutting down, if necessary, upon the point of laceration in order to pass the catheter. (The treatment of rupture of the bladder will be described under diseases of this viscus.)

Injuries of the prostate resulting from forced catheterization, if slight, recover spontaneously; if more severe, they require the **permanent catheter** to provide against retention from swelling, the use of **urinary antiseptics** and copious draughts of **water** and, perhaps also, **mild sedatives**.

Wounds caused in performing perineal cystotomy do not require any special attention.

In wounds from external causes frequent irrigations with **antiseptic solutions** and particular attention to antiseptic details are desirable, to limit the inflammatory reaction and help avoid septic inflammation of the prostatic plexus of veins. All injuries of the urethra or bladder indicate the internal use of **urinary antiseptics**.

FOREIGN BODIES AND CALCULI IN THE PROSTATE.—Symptoms.—

Pain and tenderness in the perineum and a frequent or almost constant desire to urinate, the act being accompanied by severe pain, are the prominent symptoms. Upon rectal examination the gland will be found somewhat swollen, unduly tense, and tender. Occasionally the passage of

urine is interfered with. Softening or fluctuation would indicate an abscess.

Etiology.—Small vesical calculi may lodge in the prostatic urethra, or the prostate itself. Occasionally during the introduction of an old catheter a portion will break off at the point and remain behind. At times foreign bodies have been introduced into the urethra, and, passing beyond reach, lodged in the prostate. Prostatic concretions, due to concentration and hardening of the prostatic secretion, are common in middle-aged men, but seldom attain a size causing symptoms (*e.g.*, larger than a pea); rarely, multiple prostatic calculi coalesce to form a branching mass extending forward and backward in the urethra.

Diagnosis.—This is usually made by introducing a metallic instrument, which will impart a grating sensation to the hand as it passes over the calculus or foreign body.

Treatment.—In some instances, especially in the case of impacted, small calculi, these bodies may be removed through the urethra with the urethral forceps. Bodies that cannot be thus removed should be taken out by **median perineal urethrotomy**. If suppuration should supervene, the abscess should be treated according to the principles applicable to abscesses elsewhere.

ACUTE PROSTATITIS.—This occurs in two forms: the *follicular* and the *parenchymatous*. The former is much more frequent than the latter.

Symptoms.—These vary greatly in degree, probably according to the nature and virulence of the infection. A mild prostatitis may produce no symptoms. In the mildest symptom-producing form of the follicular variety there is a sense of heat and fullness in the perineum, with some increased frequency of urination, which is attended with more or less pain, especially at the close of the act. In the more marked cases the fullness is replaced by severe pain, urination may be frequent and painful and ac-

accompanied with tenesmus, or there may be complete retention. Sitting and defecation may cause considerable pain, and examination of the prostate through the rectum will show the organ probably enlarged and distinctly tender.

In parenchymatous prostatitis, in which all of the structures of the prostate are involved, pain is more marked than in the follicular variety, and is frequently of a throbbing character. Frequent urination and tenesmus are greater, or more probably there will be retention from the extent of the swelling. In the follicular variety there is usually moderate fever. The parenchymatous form is apt to cause a higher temperature, with marked constitutional symptoms, and not infrequently chills.

The usual history is that, following a urethritis, the train of symptoms above mentioned has developed more or less suddenly. This should always excite suspicion of a prostatic complication. The condition is to be distinguished from acute cystitis, in which frequent and painful urination is more pronounced, while the complaints connected with the perineum and rectum are proportionately less. In inflammation of Cowper's glands the symptoms are confined to the perineum. In all cases digital examination of the prostate is the final test.

Abscess formation either in the prostate itself or in the cellular tissues outside the gland (periprostatitis) frequently follows, the latter condition producing a large, boggy, tender, prostatic mass.

Etiology.—In the vast majority of cases prostatitis is due to infection from a posterior urethritis. Among

other possible factors, traumatism is probably one of the rarest. Exposure to conditions causing internal congestions (a "cold") is a more common cause. Occasionally a passing or impacted calculus in the prostatic urethra or some other foreign body will excite inflammation. Excessive use of cantharides will in some instances have the same effect, as may also irritating injections or strong chemicals in the deep urethra. All these factors very probably act by establishing a favorable soil for the development of micro-organisms. Evidence is lacking to show that horse-back-riding and bicycle-riding are productive of prostatitis if proper saddles be selected. Acute prostatitis occasionally develops in the course of the infectious fevers, and it has been noted in a number of instances of pyemia.

Treatment.—The patient should be confined to bed. The diet should be liquid—chiefly milk. Water may be given freely. A hot-water bag may be applied to the perineum and rectal injections of hot water administered 3 or 4 times a day. In the more severe cases the bed should be so arranged that the patient's hips are on a higher level than the shoulders. If the inflammation is of a high grade, considerable relief is afforded by the application of a number of leeches to the perineum and around the anus. Sitz baths at 100° to 105° F., frequently repeated, give relief by drawing the blood to the surface. If there is marked vesical irritation great relief will be afforded by a mixture of boric acid, sodium bromide, and tincture of belladonna. Suppositories of ichthyol may with advantage be used, and hexamethyl-

enamine given by the mouth. If there is much fever, a **diaphoretic mixture** containing **potassium citrate**, **sweet spirit of nitre**, and **aconite** will be useful. If pain is excessive, a little **morphine** may be added. If this fails, **suppositories of morphine or opium** may be given in addition. If there is retention, the urine should be drawn at regular intervals with a soft-rubber **catheter**. If the inflammation goes on to suppuration, it is well to **evacuate** the abscess as soon as softening or fluctuation is detected by rectal examination. This should be done in the midline of the perineum, carefully avoiding the urethra and rectum. Small, circumscribed abscesses which will probably not be detected, usually rupture spontaneously into the urethra.

CHRONIC PROSTATITIS.—

Symptoms.—One of the most prominent symptoms is a persistent urethral discharge, often mucopurulent in character. Sometimes this fluid is obtainable only by massage of the prostate. Discharge may occur at intervals throughout the day, but is especially noted during or after an action of the bowels. In addition, the patient will have at least some of the following symptoms: Frequency of urination, weight and dull pains in perineum and loins, a tickling sensation or pain in the urethra, pain at the end of urination, some perineal tenderness which may make sitting uncomfortable, and a moderately increased sensitiveness of the prostate on rectal examination. The lumbar pains are typically constant in character and uninfluenced by micturition. Referred abnormal sensations may be felt anywhere below the umbilicus, even at a point as distant as

the foot. Obstruction to urination due either to **bar formation** at the median isthmus or to **stricture** of the neck of the bladder, occasionally becomes a salient feature. There is often some enlargement of the prostate gland. Introduction of a catheter is likely to reveal marked hypersensitiveness of the prostatic urethra. The urine usually shows some cloudiness, especially the first portion, owing to shreds of mucopurulent matter and masses of epithelium from the prostatic urethra. Often, in fact, chronic posterior urethritis coexists, and sometimes also chronic anterior urethritis. An extreme degree of anxiety and mental depression is very constantly observed, the seriousness of the various symptoms being magnified by the patient, particularly the discharge, often erroneously supposed by the laity to be semen.

Diagnosis.—Chronic prostatitis must be differentiated from chronic cystitis, vesical calculus, prostatic hypertrophy, and seminal vesiculitis. In the first of these the mental depression and the prostatic tenderness are absent. If the urine be passed in two portions, in prostatitis, the second portion will be clear, while in cystitis both portions are cloudy.

Vesical calculus is excluded if the characteristic symptoms are not present and by the careful use of the sound.

Hypertrophy of the prostate usually begins after the fiftieth year of life, and is much more common after the sixtieth year. The distinction is sometimes difficult, the hypertrophy not infrequently showing some degree of associated chronic inflammation. The cloudy condition of the first portion of urine in the two-glass

test, together with the mental condition and purulency of the expressed secretion, point to inflammation of the prostate, and their absence argues against it.

Seminal vesiculitis, when chronic, closely simulates chronic prostatitis. Digital examination through the rectum will, however, show an absence of changes in the prostate and probably reveal a distended seminal vesicle. For doubtful cases Posner has proposed the following test: An ounce or two of urine is passed in one glass and a like portion in a second glass, a quantity still being retained in the bladder. The prostate is then thoroughly expressed by massage either with the finger in the rectum or an instrument devised for the purpose. The patient then passes the last portion of urine. If chronic prostatitis be present this portion will be cloudy and the microscope show pus-corpuses, shreds, epithelium, probably micro-organisms, and possibly blood. Care must be taken in this test not to confound the fluid from a distended vesicle, if such exists.

Etiology.—Chronic prostatitis develops insidiously as such, or remains as a sequel of an acute inflammation. By far the commonest cause of the condition is gonococcal posterior urethritis, Keyes, *e.g.*, having noted a history of gonorrhea in 73.2 per cent. of a series of cases studied. Among other causes of it are irritating injections; improper use of urethral instruments; infection from the blood-stream; foreign bodies, such as prostatic calculi, and conditions causing a chronic congestion, such as abnormal sexual practices, constipation, hemorrhoids, etc. There occurs also probably a chronic pyo-

genic infection in which either the dose of the germs is so small or the virulence so mild that only a mild reactionary inflammation results. Such cases may complicate chronic gonorrhea and urethral strictures. Nott-haft, examining 120 cases of chronic prostatitis bacteriologically, found the gonococcus in 47; other micrococci, in 119; bacilli, in 15, and other bacteria, in 14. Young and his associates, however, more recently obtained a bacterial growth on agar in only 8 out of 19 cases.

Treatment.—Every factor of **prostatic congestion** should be removed as far as possible, *e.g.*, a contracted meatus, urethral stricture, constipation, etc. Sexual excitement should be avoided. **Tonics** are frequently indicated. The diet and digestion should receive attention as well as such matters as **exercise, bathing**, etc. Irritating articles such as Cayenne pepper, mustard, sauces, vinegar, pickles, tomatoes, and other acid vegetables and fruits, must be avoided.

Counterirritation to the **perineum** by the daily application of equal parts of **tincture of belladonna** and **tincture of iodine**, or by the occasional application of **blistering collodion**, will be beneficial. The daily use of a **jet of cold water** on the perineum from a bidet is of value in most cases, the cold and the force of the stream both causing reflex contraction of the congested blood-vessels. In some cases **hot hip-baths** for a few moments each day are of service. **Ichthyol suppositories** may be prescribed.

In rebellious cases **silver nitrate** may with advantage be introduced into the prostatic urethra through a special (Ultzmann or Keyes) syringe with long, hard-rubber nozzle. At

first only 3 to 5 drops of a 1 per cent. solution should be introduced. This may be repeated after three to five days. The strength of the solution may then be very gradually increased. If this be done too rapidly or the first application be unduly strong, considerable reaction and distress will result. Some advise the gentle introduction of a full-sized cold-steel sound every three or four days.

Many believe **massage** to be the ideal and rational therapy for chronic prostatitis. It empties the ducts, improves the circulation, and tends to cause absorption of inflammatory products. For this procedure the patient may lie on the back with the thighs flexed and separated. The massage may best be performed with a finger in the rectum, protected with a rubber finger cot, previously lubricated. Moderate distention of the bladder, if necessary with **boric acid solution**, is of advantage. The gland should be rubbed from the periphery toward the urethra, pressure being made first on one lobe, with a circular motion or a lateral sweep of the finger, then on the other lobe, and finally on the prostatic sinus, to evacuate the ducts into the urethra. If strong pressure is being made, a few strokes for each lobe are sufficient; if but gentle force is used, each lobe may be stroked for a minute. The force used is often gradually increased, but should be gauged according to the patient's tolerance and the effects noted. Brief **massage** of the **seminal vesicles** may with advantage precede the prostatic manipulations. The procedure should seldom be carried out oftener than 2 or 3 times a week. It may be continued until the symptoms have abated and the puru-

lency of the expressed fluid largely or entirely lost. Prostatic massage is contraindicated in acute inflammations of the prostate, vesicles, or urethra.

ABSCESS OF THE PROSTATE.—

Symptoms.—These cases present the symptoms of acute prostatitis in a marked degree. There is generally fever, often high, the pain is severe and often throbbing, and chills are apt to occur. Urination is extremely painful. The swollen perineum may acquire a dusky red color. Retention of urine is very often a feature; may even be the only symptom, unaccompanied by dysuria or fever. The diagnosis is confirmed if an area of softening or fluctuation can be detected by digital examination.

Etiology.—Abscess after acute inflammation of the prostate is most apt to occur where treatment has been neglected or the health of the patient is particularly depressed. The suppuration may occur early or late in the course of the disease. There may be a single abscess or a number.

Treatment.—As a rule, the abscesses undergo resolution or open spontaneously into the urethra, and complete recovery occurs. As soon as distinct fluctuation is detected, however, it is desirable not to wait, but to evacuate the abscess by an incision in the perineum, avoiding the urethra and rectum. The cases in which this will be necessary are, however, comparatively few. The wound should be packed with gauze and redressed daily. Occasionally the abscess bursts into the perineum, ischiorectal fossa, or rectum, or burrows into neighboring tissues, even as far as the umbilicus; hence the desirability of early evacuation.

PROSTATORRHEA.—Symptoms.

Prostatorrhœa refers to the periodical discharge from the urethra of a colorless or slightly turbid, whitish, viscid fluid, most frequently observed after the passage of a hard stool, but, in pronounced cases, also at other times, e.g., after violent exer-

cise, bicycle-riding, or sexual excitement. The discharge is found on examination to be prostatic fluid. Irritability of the bladder, with frequent micturition, often coexists, as do also neurasthenic symptoms. At times spermatorrhea and impotence are associated.

Etiology.—The condition occurs almost always in young adults, and seems often to be due to a relaxation of the prostatic ducts, not necessarily accompanied by local inflammation, but often the result, in turn, of sexual excess, ungratified sexual desire, or some other factor causing local congestion or weakness (prolonged fever). With this may be coupled overactivity of the prostatic glands.

Treatment.—This consists in the correction of bad habits or other ascertainable causes, removal of the hyperesthesia or prostatic congestion by daily irrigations with 1:4000 silver nitrate solution with introduction of the cold sound every 4 or 5 days, and sedation of the irritable bladder with hot hip-baths at night and bromides and hyoscyamus.

ATROPHY OF THE PROSTATE.—The prostate undergoes atrophy in a small proportion of old subjects, and may also atrophy after severe trauma, suppurative involvement, or calculous formation. Congenital atrophy is likewise a possibility. In eunuchs the growth of the organ is arrested, and in cases of destruction or removal of the testicles, or ligation of the vasa, after puberty it tends to retrogress. No symptoms result from the condition, and treatment is unnecessary.

HYPERTROPHY OF THE PROSTATE.—SYMPTOMS.—Considerable enlargement of the prostate may occur without any subjective symptoms whatever. On the other

hand, a very moderate or slight enlargement in other cases may give rise to considerable annoyance. The first symptom to attract the patient's attention is, almost without exception, increased frequency of urination (*pollakiuria*), especially at night (and particularly toward morning). The patients are obliged to rise once or twice during the night to pass water. No change is usually noticed at this stage during the day. The nocturnal frequency gradually increases and finally the diurnal frequency is also augmented. An observing patient may note that the natural force of the stream is lacking, that it is thin and tends to fall vertically downward. There is also apt to be some hesitation in starting the stream, and stoppage is frequently incomplete. Chilling, worry, and alcoholic overindulgence augment the frequency of nocturnal micturition.

The subsequent course of the case depends, to some extent, upon whether the urine remains sterile or becomes infected. In the former case, as the prostatic overgrowth progresses, there is corresponding obstruction to emptying the bladder. At the conclusion of each act of urination a portion of the urine remains. The bladder therefore becomes distended much earlier than if it had been completely emptied. This, in conjunction with the increased local irritability due to congestion of the bladder and prostate, is the cause of the more frequent passage of urine. When the amount of residual urine reaches several ounces to a pint or more, it naturally requires but a short time for the bladder to become fully distended and call for relief. The organ at no time feels empty. In

some cases the obstruction is so great that normal urination is impossible; the bladder becomes distended to its utmost limit, and the urine escapes involuntarily from the urethra as fast as it enters the bladder from the kidneys. This dribbling is a significant symptom, and constantly deceives the patient and not infrequently the physician, the argument being that, owing to the frequent or almost constant passage of urine, the bladder must be empty. Though generally due to overflow in a filled bladder, dribbling may occur, with but little residual urine, owing to abnormal irritability of the bladder. Not infrequently dribbling is the original symptom leading the patient to consult a surgeon.

If the urine becomes infected, as is sooner or later always the case, often as a result of catheterization, the symptoms become very marked. Urination may occur every two hours, every hour, or even 3 or 4 times in an hour. There may or may not be hypogastric pain, depending upon the degree of cystitis present, and the act of urination is apt to be attended with vesical tenesmus. In rare cases in which there is moderate enlargement of the prostate, but in which the symptoms have been so mild as to escape observation, after the patient has been chilled or indulged in alcohol, or has gone an unusually long time without passing water, he may find himself unable to do so, and resort to the catheter will be necessary. This retention may be the first evidence which the patient has had that the prostate is affected.

The amount of pain varies in different cases. In the milder forms it is usually entirely absent. In more

pronounced types the patient will complain of indefinite pains in the hypogastrium, the groins, or the small of the back, and a sense of fullness in the perineum or rectum. In the later stages more or less severe pain will be present either because of a distended bladder or of cystitis. There may be a soreness or smarting of the urethra and shooting pains in the glans, similar to those felt in cases of vesical stone. In cases with severe cystitis in which frequent and violent efforts are made to pass water, the tenesmus may result in hemorrhoids or prolapsus ani.

In the later stages, the urine is very apt to contain blood, sometimes in microscopic quantity only, in other cases in large amount. As long as the bladder remains uninfected there are no characteristic changes in the urine. In the presence of infection the usual evidences of cystitis will be observed.

The enlarged prostate sometimes causes a marked erethism or even priapism. The residual urine and the resulting ammoniacal decomposition predispose to the formation of phosphatic calculi. Patients with prostatic enlargement frequently have a stone in the bladder. Seminal vesiculitis is also a common, and epididymitis (often suppurative) an occasional, complication of prostatic hypertrophy.

DIAGNOSIS.—The diagnosis of enlargement of the prostate is, as a rule, attended with little or no difficulty.

Among the conditions which may cause more or less similar symptoms are stricture of the urethra, stricture at the neck of the bladder, prostatitis, cystitis, vesical calculus, and tumor

of the bladder or the prostate itself. Stricture of the urethra will be eliminated if a full-sized urethral instrument can be passed without obstruction. Stricture at the neck of the bladder is differentiated with the cystoscope, which will reveal a localized prostatic thickening (prostatic bar) even in the absence of enlargement of the prostate to the rectal touch. Prostatitis, if acute, would be most apt to follow urethritis, and would be accompanied by fever and much more marked local tenderness than exists in the senile prostatic hypertrophy. The chronic form usually occurs in earlier life, and leads to the characteristic symptoms already referred to. Vesical calculi, if present, may be detected by the use of a vesical sound. Vesical tumors may be suspected after excluding stone and enlarged prostate (by rectal palpation) and diagnosed *de visu* by cystoscopy. (For the differentiation of prostatic neoplasm, see section on Tumors of the Prostate.)

The final test for enlargement of the prostate is digital examination through the rectum, the finger encountering, instead of the normal soft organ, a dense, rounded, smooth, and generally symmetrical mass. Simultaneously the bladder may with advantage be palpated and the condition of the urinary stream and the urine itself noted. The patient should invariably be examined for residual urine by gently passing a catheter immediately after he has emptied his bladder as completely as possible, an elbowed or double-elbowed woven catheter being used if the ordinary soft-rubber catheter fails to pass. Atony of the bladder is shown by a feeble jet of urine or inability to start

the flow while recumbent. A significant increase in the urethral length is shown if urine fails to flow when the catheter has been passed in 2 to 2½ inches beyond the point where the resistance of the cutoff muscle is first felt. The length of the urethra is increased in some cases to the extent of 1½ to 2 inches. The cystoscope may be of material assistance in reaching a diagnosis.

ETIOLOGY AND PATHOLOGY.

—After a large number of post-mortem dissections Sir Henry Thompson claimed that 1 man in every 3 over 54 years of age showed some enlargement of the prostate. In about 1 case in 7 the enlargement was sufficient to cause some degree of obstruction, and in 1 case in 15 it was sufficient to demand treatment. The condition is so common at and after the sixtieth year that some writers have described it as physiological. This view does not seem justified, since according to most observers, in perhaps two-thirds of the population, there is no increase in size whatever. Johnson, however, among 360 men asserts he found prostatic hypertrophy in 70 per cent.

Prostatic hypertrophy seems to occur with about equal frequency in the various classes of society; nor do the habits of the individual, so far as can be learned by inquiry, seem to bear any relation to it. The efficiency of such factors as senile involution, sedentary life, gonorrhea, and sexual excess in predisposing to the condition is as yet undetermined.

The normal prostate consists chiefly of 2 lateral lobes, with a small intermediate portion sometimes called the middle or third lobe. In some cases the increase in size appears to include

all parts of the gland about equally—a true hypertrophy. In others, it involves only one portion or one lobe,—strictly speaking a hyperplasia. Minutely, the hypertrophy may occur in 3 types: (1) the soft, “adenomatous” type, with obstruction of the ducts of the prostatic acini and cystic dilatation of the latter; (2) the hard, fibrous type, and (3) the pseudoadenomatous type, characterized by the growth of encapsulated, enucleable nodules, small or large, in various parts of the gland. As a rule, all 3 of these types are to be found in a single prostatic specimen. According to the widely recognized theory of Ciechanowski, the condition is originally due to a chronic inflammation of the stroma of the prostate, causing duct obstruction, later scar formation (the fibrous type), and encircling of portions of gland-tissue by dilating ducts to form the characteristic pseudoadenomata.

Non-symmetrical enlargements of the prostate more easily produce symptoms than symmetrical. Urinary obstruction may result from even a slight hypertrophy of the middle lobe. Either general or middle-lobe hypertrophy causes elevation of the posterior margin of the urethral inlet—the so-called “prostatic bar”—forming behind it a pouch in which the “residual” urine collects.

PROGNOSIS.—The prognosis in early cases is good if treatment be forthwith instituted. Even after acute retention, five or six years generally elapse before chronic complete retention is reached. Where partial or complete chronic retention is already established the tendency, unless radical treatment is submitted to, is, infection of the bladder having oc-

curred, toward extension of the resulting inflammation up the ureters to the kidneys, causing chronic pyelonephritis and a urinary septicemia which leads eventually to death. Yet by good management of the retention even in these cases, to minimize the back pressure on the kidneys, progress of the renal infection and functional deterioration may be greatly slowed.

TREATMENT.—In the earlier stages, with slightly increased frequency of urination only, comfort may be much increased by careful **hygiene**. The hypertrophic prostate being chronically congested, everything tending to increase this should be avoided. The body should be properly protected, to avoid catching cold. The food should be **plain**, easily digested, and **non-stimulating**; meats should be sparingly taken, and a diet largely of **milk** may be recommended. The bowel function should also be attended to. Regular, moderate **exercise** is desirable.

Irritability of the bladder, as yet unaccompanied by residual urine, may also be treated by **silver nitrate** instillations or by **massage of the prostate** and the **rectal douche**. Acute retention of urine may require **catheterization**, to be done with strict cleanliness and coupled with internal administration of **hexamethylenamine**. Great caution should be exercised when the bladder contains more than 1 liter of urine. It is usually best to withdraw part at a time, so as to relieve the overdistention gradually.

If the residual urine be 3 or 4 ounces (90 to 120 c.c.), a soft **catheter** should be passed once daily, preferably at bedtime, to give a longer

period of rest at night. If it be 5 or 6 ounces (150 to 180 c.c.), the urine should be withdrawn morning and evening, and, if half a pint or more, it is desirable to pass the catheter every eight hours. After withdrawing the urine it is desirable to irrigate the bladder with warm **boric-acid solution**, 10 or 15 grains (0.6 or 1 Gm.) to the ounce (30 c.c.). If there be pronounced cystitis, it may be necessary to pass a catheter oftener, and the bladder irrigations then become especially important.

No drugs have any direct influence upon the prostatic overgrowth, unless it be **ergot**, and opinion as to the latter is divided. Half a teaspoonful of the **fluidextract** may be given 3 times a day for a considerable period. **Strychnine** and other **tonics** are often indicated for the general condition.

In catheterizing these patients, difficulty is often experienced as the instrument reaches the prostatic urethra. For this reason it is necessary in some instances to try different forms of catheters. The **elbowed catheter** is useful in difficult cases, and the metal **prostatic catheter**, with longer shaft and larger curve, will sometimes pass easily when all other forms are arrested. In troublesome cases the gentle passage of **sounds** or the **retention** of a rubber or woven **catheter** for a few days will often greatly facilitate subsequent catheterization. It should be an invariable rule to use thorough asepsis in all of the urethral instrumentation, to avoid cystitis. The patient practising **autocatheterization** must be thoroughly instructed by the surgeon in this connection. Some advise that $7\frac{1}{2}$ to 15 grains (0.5 to 1 Gm.) of **hexamethylenamine** be ordered

taken daily throughout catheter life. By gentle, cleanly, and infrequent (though regular) use of the catheter, a reduction in the amount of residual urine can often be procured.

Operative Treatment.—The palliative treatment hereinbefore described is disadvantageous in not being curative, in the possibility that it may at any time fail to relieve, and in the fact that the patient is not removed from the danger of complications such as prostatic abscess, epididymitis, orchitis, and especially ascending infection of the urinary tract. Radical treatment, on the other hand, always entails a certain chance of immediate operative death. It is indicated, therefore, only when palliative treatment proves insufficient and the patient is seen to be gradually failing in spite of careful management of the case. Under these circumstances to delay operation only serves to lessen the chances of operative recovery. Of the operative procedures recommended for enlarged prostate, the following deserve mention: (1) **vasectomy**; (2) **galvanocauterization**; (3) **cystotomy**, for drainage, either perineal or suprapubic; (4) **prostatectomy**.

Vasectomy, which grew out of the operation of castration, recommended by White in 1893, is the mildest of the procedures. Yet it has been followed by a small mortality (3 to 5 per cent. in early cases; 10 per cent. or more later) due to the fact that the patients are all persons in advanced years who have suffered from chronic obstruction for some time, and who, in consequence, are apt to have cystitis, dilated ureters, and surgical kidneys. Relief, more or less pronounced, follows **vasectomy** in about 60 per cent. of the cases. In some conditions seem to return approximately to normal. The operation may be tried in patients with moderate

enlargement and several ounces of residual urine, in whom the difficulty or pain in passing a catheter demand other treatment, and who are old and feeble.

Substitution of a tunneling operation for prostatectomy in many cases recommended. Destruction of the obstacles to urination is effected with the writer's direct vision air cystoscope and the galvanocautery. The prostatic bar is cut vertically by the cautery and the cut then opened out laterally like a broad V. The second step consists in destroying the lateral lobes with the cautery as one would dig a hole in a potato, the cystoscope being gradually drawn forward. The operation is best done in 3 to 6 weekly sittings. It is safe and does not need general anesthesia. Luys (Bull. de l'Acad. de méd., Feb. 12, 1918).

Galvanocauterization.—A. BOTTINI'S OPERATION.—This method, originated by Bottini, of Padua, in 1874, meets the requirements better than any other in cases in which there is a distinct bar at the neck of the bladder. The operation is carried out by means of a *prostatotome*, constructed somewhat on the principle of a lithotrite. What would correspond to the male blade, however, has at the extremity a platinum-wire loop which is heated by an electric current. After the introduction the blades are turned in the direction in which it is desired to make the section of the prostate—generally posteriorly, toward the rectum,—the current gently turned on for a period previously found by trial to be required for bringing the blade to a red heat, and the wire loop made to cut through the obstructing mass by means of a screw attached to the handle. A second and a third section (usually lateral) may be made if it is thought necessary, the blade returned to its sheath, and the instrument removed. Before beginning the operation the bladder should be partially filled with **boric acid solution** and the posterior urethra anesthetized. During use of the instrument a current of cold water is kept constantly passing through it, to prevent overheating. The patient need remain in bed only twenty-four hours. A steel sound may, with ad-

vantage, be occasionally passed during the period of healing.

The mortality of Bottini's operation ranges from 2 to 6 per cent., the deaths being due chiefly to infection of the incised prostate or to infiltration of urine due to penetration of the instrument beyond the prostatic structures. In some instances no benefit follows the operation.

B. CHETWOOD'S OPERATION.—The necessity of conducting Bottini's operation entirely in the dark, without a guide, is a manifest objection to the procedure. This has led some to substitute for it the Chetwood technique, which consists in exposure and incision of the membranous urethra as in median perineal prostatectomy (see below), examination of the prostatic urethra and bladder outlet with the finger and, a bar, stricture, or enlarged median lobe having been found, the **Chetwood prostatic incisor**, introduced through the perineal wound and hooked over the prostate, the index finger of the left hand passed into the rectum and brought in apposition with the point of the instrument, the current turned on, and the hypertrophied tissues divided by slow withdrawal of the knife, the surrounding tissues being meanwhile kept cool by a small stream of water passing in through the urethra and out through the perineal wound. The effect produced is controlled by subsequent introduction of a finger in the urethra. Where a median lobe requires broad excision two **cauterizations in a V-shape** with the knife may be made.

Cystostomy, perineal or suprapubic, may be carried out either for temporary drainage or to establish a permanent new urinary channel. In the former case, the resulting physiological rest, in a few cases, affords sufficient relief of prostatic congestion to permit the urine to flow through the normal channel. If this flow cannot be re-established, a tube may be inserted into the bladder for permanent drainage. Several forms of these tubes have been devised. The annoyance of wearing the permanent tube, however, the irritation of the surrounding skin, and the continual soiling of the clothing render the patient's life anything but happy. Hence the late tendency to restrict the field of cystostomy to serious cases in

which temporary bladder drainage is of value as a preliminary to prostatectomy, relieving renal retention and sepsis, and enabling the patient better to bear the shock of the subsequent remedial operation.

Prostatectomy must always be regarded as a severe operation. Occasionally a circumscribed enlargement of one portion of the prostate may be easily and safely removed through a suprapubic opening; but the removal of the entire gland is often a tedious procedure, usually attended with severe hemorrhage. The average mortality of prostatectomy by the perineal route is about 6 per cent.; that of suprapubic prostatectomy somewhat higher—8 per cent. or more. With the latter the chances of a complete cure are, on the whole, greater than with the former, which is more difficult of performance, and is occasionally followed, even in the hands of the best operators, by incontinence of urine or a urethrorrectal fistula. Convalescence from the suprapubic operation, on the other hand, is far slower than from the perineal. Where preliminary cystoscopy is impracticable, the suprapubic procedure is that of choice, allowing of a careful investigation of the condition of the bladder-neck which the perineal method does not afford. Whichever procedure be employed, prostatectomy yields a cure in the great majority of cases.

Suprapubic Prostatectomy.—This procedure is generally carried out by the method of Freyer, a modification of the earlier McGill and Fuller operations. The bladder having been washed out and filled with boric acid solution, a vertical opening is made into it through a suprapubic incision, any calculi found in it removed, and the prostate palpated, one or two fingers of the left hand making counter-pressure on the gland from the rectum. The mucous membrane overlying any prominent enlargement of the prostate may be divided by the finger-nail or the points of scissors. The index finger is then passed through this cut, between the gland and its capsule, and carried around, in this line of cleavage, the whole of the enlarged portions of the gland, which are then torn or cut away, including the pros-

tatic urethra. An attempt may be made to work between the lateral lobes and the prostatic urethra and save the latter; this maneuver is, however, rarely completely successful, and experience has shown that the prostatic urethra may be removed or torn without harmful results. Finally, the prostate is removed from the bladder with forceps, and a large (Freyer) drainage-tube, with small catheter attached, passed in to the neck of the bladder for continuous irrigation. The enucleation should be done with care and gentleness, keeping close to the capsule of the gland. Where the prostate is found so fibrous and adherent as to render its enucleation without undue tearing of the capsule impracticable, sufficient functional benefit may be obtained by merely using the actual cautery on the prostatic bar or excising a V-shaped piece therefrom.

Perineal Prostatectomy: A. Median.—The bladder having been irrigated and filled, a grooved staff is introduced through the urethra, a median incision made in the perineum, and the urethra opened into just anterior to the prostate. A finger is introduced to explore the prostate and bladder-neck through the urethra, and the lobes, in turn, freed from the capsule with the finger through a deep incision made in each of them through the lateral aspect of the urethra. The lobes are loosened as much as possible from the prostatic urethra, pieces of which, however, are usually torn off as the lobe is being drawn out with volsellum forceps. The middle lobe is, if necessary, similarly dealt with. The pediculated median lobes sometimes met with may be removed with a tonsil snare. A double irrigating tube is finally introduced and irrigation at once begun, to be continued several hours. Hemorrhage from a tear of the prostatic capsule is controlled with gauze packing. The perineal tube is usually to be removed in two days, and the patient should preferably be got out of bed soon after.

B. Extraurethral.—Extraurethral perineal prostatectomy, though used to a large extent by Young and Albarran, is more difficult than the median operation, and is useful chiefly where the obstruction is due to hypertrophy of the lateral lobes or a short hypertrophy of the median tis-

sue. Lateral converging incisions, with the apex of the V anterior, are made, the rectourethralis muscle severed, the posterior surface of the prostate exposed by blunt dissection, the membranous urethra incised, the prostatic urethra and bladder-neck palpated with a finger in the urethra, the lateral lobes removed through incisions made into them from the outside, 1 centimeter from the midline, any further masses felt by the finger within similarly taken out, the prostatic incisions packed, irrigation of the membranous urethra provided for, the edges of the lavator ani muscle sutured, and the lateral parts of the skin incision closed.

Impotence follows any form of prostatectomy in a considerable proportion of cases—seemingly somewhat oftener after the perineal than after the suprapubic method. It is attributed to destruction of the prostatic urethra as well as to operative shock. Other possible complications—of perineal prostatectomy in particular—are epididymitis, urinary incontinence, and retention of urine, the latter due to incomplete operation, the obstruction to urination remaining unrelieved.

TUBERCULOSIS OF THE PROSTATE.—**Symptoms.**—Perhaps one-third of these cases are entirely free of symptoms or have so little inconvenience that the disease is unsuspected. In the milder forms there is slight irritation of the bladder, with some frequency of urination, which may be attended with burning pain. There is a feeling of fullness or weight in the perineum; there may be a mucopurulent discharge from the urethra, and a similar sediment in the urine. Hematuria is also often observed, and is occasionally the first sign of the disease.

Diagnosis.—A consideration of the symptoms and careful exploration by the sound will serve to make the distinction between prostatic tuberculosis and vesical calculi. The presence of tuberculous deposits elsewhere should excite suspicion. Finding tubercle bacilli in the urine would be conclusive, but Guyon states that the most careful examination fails to detect them in 50 per cent. of the cases. Digital examination per rectum may show some local enlargement and tenderness, and prostatic massage is likely to yield muco-

purulent matter, in which tubercle bacilli may be found.

Etiology.—The disease is generally believed to be invariably secondary to deposits elsewhere in the genitourinary tract, though some consider it primary. A chronic posterior urethritis sometimes precedes it. Usually it occurs in anemic persons with tuberculous foci elsewhere, chiefly between the twentieth and forty-fifth years. It is usually manifest in circumscribed collections of cheesy material or abscesses. The latter tend to rupture into the urethra, initiating a tuberculous cystitis. Until such rupture occurs there is often no symptom.

Treatment.—Prostatic tuberculosis can be, to some extent, guarded against if those with tuberculous tendencies avoid all influences tending to cause congestion or inflammation of the prostate. The treatment is chiefly constitutional, unless the local trouble demands operative interference. It is proper to delay the latter as long as possible, both because the part is not very accessible and because it is apt to be a part of a general process. Hill and others have injected iodoform and other substances into the bladder frequently with benefit. Hill's formula is as follows:—

<i>R</i> Iodoform	2 parts.
Mucilage of gum arabic.	4 parts.
Glycerin	2 parts.
Water	20 parts.

After washing out the bladder 1 dram of this mixture is introduced. This may be repeated every second or third day, depending upon how well it is borne. Parenchymatous injections of iodoform emulsion were recommended by Senn.

The question of operation will frequently come up. In general, if the health of the individual is good, and if the tuberculous process does not yield to palliative treatment, an operation is indicated. The gland may be approached from the perineum and any diseased area evacuated and thoroughly curetted. Prostatectomy is indicated only if all evidence of involvement of neighboring structures is absent. If the patient has deposits elsewhere sufficient to yield physical signs, and if the general health is poor, no operative treatment is to be recommended.

TUMORS OF THE PROSTATE.

—**Cysts** of the prostate, including dermoids and echinococcic cysts, have been rarely recorded. These almost invariably cause retention of urine after reaching a sufficient size to occlude the urethra by pressure. Upon examination by rectum a fluctuating swelling may be detected. They are treated either by **aspiration** or by **incision and drainage**.

Carcinoma.—Carcinoma of the prostate is relatively common. Greene and Brooks claim to have found a histological structure suggestive of malignancy in 5 per cent. of all hypertrophied prostates. More recent observations have led some writers to conclude that the actual incidence is from 10 to 15 per cent. It occurs in two forms: as a slowly growing, circumscribed tumor, limited to the gland itself, and as a diffuse infiltration of the prostate and base of the bladder which develops rather rapidly. The growth may be of a stony hardness, and is often characteristically nodular. It is usually of the medullary type, and is generally primary. It nearly always occurs after the age of fifty.

SYMPTOMS.—The symptoms of carcinoma of the prostate are those of obstruction from hypertrophy, except that, when once established, they run a more rapid course. Carcinoma gives rise to more pain, however, than does senile enlargement, and as soon as ulceration occurs there is hematuria. The pain is at first neuralgic in type. It may occur only when obstruction to urination develops. It is felt chiefly in the perineum or rectum, whence, however, it later radiates to the genitals, lumbar regions, sciatic nerves, and hypogastrium.

Bilateral sciatica is considered suggestive of prostatic cancer. Hematuria becomes marked when the disease bursts through the capsule of the prostate. The bladder, seminal vesicles, urethra, and remainder of the pelvis are then rapidly invaded, and metastases may take place in the inguinal, femoral, mesenteric, and retroperitoneal glands as well as in the spinal column and kidneys. Death usually follows within a year of the initial symptoms, though in some instances it is delayed for a long period.

DIAGNOSIS.—Distinction between prostatic carcinoma and hypertrophy is at first difficult and may be impossible. Unilateral enlargement, one or more nodules in the gland (prostatic calculi being excluded by the X-ray), a stony hardness of the growth, unusual pain, and spontaneous hemorrhage are all somewhat suggestive, but not plainly indicative, of cancer. Later, the wide distribution of the pain, rapid course, foul, bloody urine, cachexia, extensive prostatic enlargement, and palpable secondary involvements remove all doubt in the diagnosis. Cystoscopy may be of assistance.

TREATMENT.—This is chiefly **palliative**. At first, **systematic cauterization**, **tonics**, and **sedatives** may prove of service. Later, excessive pain must be met by **morphine internally** or by **suppository**. **Permanent drainage by suprapubic cystotomy**, together with **colostomy** when rectal ulceration or obstruction develops, are appropriate palliative procedures. Operations for radical removal of a cancerous prostate have not proved generally satisfactory. Young and a few other operators have reported a few successful cases. The diagnosis

usually being made relatively late, removal of the entire prostatic capsule and the neck of the bladder is, at the least, required to eliminate the disease focus *in toto*.

Sarcoma.—Sarcoma of the prostate usually occurs in early life. The common symptoms are dysuria, retention, hypogastric and perineal pain, and the presence of a tumor. Hematuria usually occurs. The disease runs a more rapid course than any other prostatic affection.

Treatment.—The treatment is symptomatic and palliative. An operation would be proper only in the most exceptional case.

DISEASES OF THE BLADDER.—The subjects of ACUTE AND CHRONIC CYSTITIS have been reviewed in the third volume, page 712.

ANOMALIES.—Absence of the bladder and double bladder are extremely rare congenital deformities.

Urachus cyst or fistula is a rare condition arising through failure of the canal connecting the bladder with the umbilicus to close during fetal life. Where the canal remains open throughout, a fistula results; if only in part, a cyst, which may attain a large size. Urachus fistula is generally associated with obstruction in the urethra, and may even become manifest only in adult life after some affection causing such obstruction has been contracted.

TREATMENT.—The first care should be to overcome any existing urethral obstacle. Injections of irritants, such as alcohol, into the canal may then induce its closure. If not, it should be excised.

EXSTROPHY OF THE BLADDER.—Exstrophy, or absence of the anterior wall of the bladder (*ectopia vesicae*), is by far the commonest congenital defect of this organ. It results from the failure of the lateral portions of the urogenital cleft to unite. It is most frequently observed in male children (37 to 12—Pousson),

and is accompanied by absence of the roof of the urethra (*epispadias*) and by a defect in the anterior abdominal wall in front of the bladder, the pubic bones being separated by a more or less wide interval, so that the mucous surface of the posterior wall of the bladder protrudes in the hypogastric and pubic regions. The ureteral orifices can usually be found upon careful inspection. Subjects of this deformity are usually poorly developed and are apt to have other defects also. In some cases the scrotum is cleft, so that the external genitals of a male child may somewhat resemble those of a female. The testes are occasionally undeveloped, and may or may not occupy their proper position in the scrotum. Inguinal hernias are common. The protruding vesical mucous membrane is thickened, ulcerated, and bathed in mucus, and the constant contact of the ammoniacal urine with the surrounding skin gives rise to a troublesome eczematous condition. Eventually the bladder inflammation travels up the ureters, causing pyelonephritis, and the twenty-first year of life is reached only in 30 per cent. of instances.

Treatment.—The palliative treatment consists in the use of some form of urinal to collect the urine or of other means to keep the patient as dry as possible. The urinals customarily used (Earle's, for example) consist of a round, bulging, metallic shield, the rounded margin of which forms a groove around the bladder defect. This is supported by a truss and is connected below by a tube with a rubber bag fastened to the thigh. The surrounding skin should be frequently bathed, and, if irritated, zinc ointment applied. In very young

children the use of a urinal is impracticable; cleanliness is to be maintained with hot water and irritation minimized with ointments or dusting powders.

The radical treatment consists in some form of **plastic operation**, usually intended to close in the bladder sufficiently to enable the urine to be caught in a urinal.

In suitable cases it is advisable to free the edges of the bladder and unite them by sutures, leaving an opening below for the escape of urine.

Wood's operation is the autoplasmic procedure usually recommended, and is performed by taking a flap, of sufficient length and width, from the anterior wall of the abdomen, to cover in the extroverted border of the bladder, and so folded over the protrusion that the skin is next to the mucous membrane and the raw surface **external**. Two rounded lateral flaps with the attached portions corresponding to the base of the scrotum and inguinal region on either side are next made. The inner end of each incision is continued along the corresponding side of the urethral groove for one half its length. These flaps should be large enough and so fashioned as to meet in the midline. The middle flap is turned downward so that the skin covers in the bladder, and the free margin sutured to the incisions on either side of the roof of the penis. The lateral flaps are then brought together in the midline overlying the first flap and sutured. The raw surfaces from which the flaps were taken are then drawn together as far as possible, using either sutures or harelip-pins.

The epispadic condition remains to be remedied by operation at a later period.

The **autoplasmic operations** enable the patient to retain his urine for from twenty minutes to as long as two hours. No satisfactory bladder-sphincter is supplied.

Maydl's operation, when successful, permits of retention for four to six hours, but is attended with a higher operative mortality (14 per cent.—Peter-

son). It consists in cutting apart an elliptical piece of bladder-wall, including the mouths of both ureters, bringing up a loop of sigmoid or rectum from the peritoneal cavity, implanting the piece of bladder into this loop, stripping the mucous membrane from the rest of the bladder, and closing the abdominal wound as firmly as available tissues permit. In a series of 36 cases collected by Peterson, this operation afforded good control of the urine in 27 instances.

RETENTION OF URINE.—**Definition.**—Retention of urine refers to a partial or complete inability to urinate voluntarily. The condition is a symptom, not a definite disease.

Symptoms.—In acute retention the patient has an intense desire to urinate and strains violently. Pain in the perineum, penis, abdomen, and thighs may be experienced. The enlarging bladder rises above the symphysis, forming a dull, elastic, fluctuating mass, less prominent in recumbency than in the upright position, and flanked by areas of tympany. When the distention reaches its limit, the urethra may be mechanically pulled slightly open, an overflow of the excess of urine taking place, without to any marked extent relieving the distention. If no such overflow is possible, a typhoid condition eventually supervenes, which will prove fatal if surgical relief is not given.

Chronic retention may follow partially relieved acute retention, and is characterized by permanent inability to empty the bladder completely. It is often very gradual and insidious in onset, causes frequent urination, and, when sufficiently marked, leads to a periodic or almost constant dribbling of urine, which represents an overflow whenever the bladder reaches a sufficient degree of distention. In such instances no especial pain may be experienced. An atonic condition of the bladder-muscle is sooner or later superimposed.

Etiology.—Retention of urine in most instances occurs as a complication of either organic urethral stricture or prostatic hypertrophy (*q. v.*). Less frequently it is due to such obstructive causes as congenital phimosis, imperforate prepuce, or occluded meatus; tumor or abscess of the penis; rough catheterization; tumor,

rupture, or impacted calculus or foreign body of the urethra; prostatitis or prostatic abscess or tumor; spasm of the membranous urethra in acute or chronic gonorrhea; perineal or ischiorectal abscess; projection of a submucous blood-clot into the urethral lumen after contusion of the perineum (Da Costa); pressure by a large pelvic mass; fecal impaction, and stone in the bladder. Occasionally it is due to disturbance of the nervous or muscular apparatus governing bladder evacuation, as in shock or peritonitis, spinal concussion, fracture of the vertebræ, diseases of the spinal cord, operations on the rectum, protracted fevers, diseases causing muscular wasting, use of belladonna, opium, or cantharides, and hysteria. Reflex retention of urine may occur either through excitation and spasm of the bladder sphincter or through inhibition of the detrusor muscle tissue itself.

Complications and Sequelæ.—Acute retention may be complicated by suppression of urine or rupture of the urethra.

Chronic retention due to obstruction in the urinary flow results in undue strain and congestion of the bladder. The latter *hypertrophies* to make up for the obstruction, but finally becomes mechanically insufficient and, as a result, permanently infected owing to the formation of a pool of residual urine in which bacteria find a nidus and multiply. The cystitis may lead to apparent further hypertrophy, which represents merely an inflammatory infiltration and sclerosis of the bladder-wall. Where the cystitis is less severe, the dilating bladder soon comes to present the appearance of *atrophy*, its wall not only being thin, but giving way in places, with formation of trabeculæ or diverticulæ. The latter constitute the essential feature of the so-called sacculated bladder, and may come to be larger than the organ itself. Whatever the severity of the cystitis, the atrophied condition of the bladder is eventually reached. The bladder containing residual urine is not infrequently complicated upon exposure of the lower limbs or dietetic or alcoholic excess, by an attack of acute congestion of the prostate, which may temporarily transform the partial into a complete retention of urine.

The kidneys in chronic urinary reten-

tion, sooner or later, feel the effects of the mechanical and other disturbances existing in the bladder. The congestion and increased pressure in the bladder, as well as the resulting hypertrophic changes and infection, are gradually transmitted along the ureters to the renal pelves, especially from the time when the retention of urine in the bladder has become complete. The sclerosis attending long-continued ureteral and renal congestion renders these structures susceptible to infection, which, however, is likely to remain mild until the back pressure has actually pouched them out. Infection with ammonia-producing bacteria is then likely to occur, and as a result gradual, progressive atrophy of the renal parenchyma takes place.

Treatment.—In acute retention arising in cases of stricture or prostatic hypertrophy an attempt should gently be made to introduce a small-sized rubber or woven silk **catheter**, always with careful aseptic precautions and lubrication. But little force should be used at any time. If the ordinary type of catheter fails to enter, one with a narrow olivary tip, or, in prostatic cases, an elbowed or double-elbowed catheter may be tried. Relaxation at the point of obstruction is favored by keeping the patient **warm** in the **recumbent** position, or, still better, by placing him in a **hot bath**, the temperature of which is gradually increased to a point as high as he can stand, even to the point of nausea and faintness. Remaining in such a bath for fifteen or twenty minutes he will often be enabled to urinate while in the water. Instead, a **hot sitz bath** at 104° F. (40° C.) may be given for a three-minute period, to be repeated a quarter of an hour later, if necessary. If these measures do not directly provoke urination, another attempt to introduce a **catheter** may be made.

When entrance into the bladder has been effected, only about one-half its contents should be drawn off the first time—about 500 to 1000 c.c. (1 or 2 pints)—rapid complete evacuation of the distended organ having occasionally caused hemorrhage, and even collapse and death. Some time later the catheter may be reinserted and the remainder withdrawn. If desired, the organ may then be washed out with

warm boric acid solution. The patient should then be kept at **rest in bed**, preferably for two days. **Hexamethylenamine** should be given by mouth in $7\frac{1}{2}$ -grain (0.5 Gm.) doses 3 times on the first day, then in 5-grain (0.3 Gm.) 2 or 3 times a day.

Where a rubber or woven instrument cannot be made to enter the bladder, a **filiform bougie** should be tried (see section on Stricture of the Urethra). The patient may, if desired, be placed under anesthesia, or an injection of **morphine** may be given. In prostatic cases a rubber catheter, stiffened by the insertion in it of a filiform bougie nearly to its tip, will sometimes enter where the catheter alone has failed. A metallic **prostatic catheter** may also be tried, but is dangerous, easily creating a false passage. When a filiform bougie has been successfully employed a **Gouley tunnelled catheter** may be threaded on it and passed into the bladder; or, the filiform may be simply fastened in place, acting as a capillary drain which will evacuate the bladder in the course of a few hours. If a general anesthetic has been given, the patient should then be well covered, **heat** applied to the **hypogastrium** and perineum, and **suppositories of opium** and **belladonna** employed. Later insertion of one or more additional filiform bougies is sometimes advisable in the stricture cases. **Rest in bed** should be ordered until the local congestive process has abated, when **dilatation** of the stricture or any other curative measures indicated may be undertaken.

In occasional cases all attempts to pass a catheter or filiform into the bladder will prove fruitless. In such instances temporizing by **aspiration of the bladder** every eight hours for one day, or even longer, will sometimes result in such abatement of the obstructive congestion that a filiform or catheter can finally be passed, especially if preceded by a hot bath. Aspiration should be preceded by percussion of the hypogastrium, to make sure that the bladder is directly under the abdominal parietes, and by local shaving and antiseptic cleansing, *e.g.*, with **tincture of iodine**. A sterile aspirating needle $1\frac{1}{2}$ inches (4 cm.) long is then pushed backward and downward into the bladder from

a point about $\frac{1}{2}$ inch (1 cm.) above the symphysis pubis. Negative pressure is then applied and about one-half the urine in the bladder withdrawn. Suction is kept up as the needle is being pulled out. The puncture may be covered with iodoform and **collodion**. Infection of the needle track is uncommon, and is treated by **incision and drainage**.

Where the insertion of a bougie or catheter is impossible, even after aspiration for twenty-four hours or longer, some more radical operative procedure is imperatively indicated (see Stricture of the Urethra and Hypertrophy of the Prostate, in this article). Where circumstances permit, such a procedure is often promptly undertaken without resorting to aspiration.

Acute retention of urine due to causes other than stricture or hypertrophied prostate may require different measures. In simple inflammatory obstruction **hot sitz baths**, **hot-water** or **sand bags** to the hypogastrium and perineum, and **suppositories of opium**, together with **rest in bed**, will often suffice; if not, a **soft catheter** may be used. In phimosis the **prepuce** should be longitudinally **split** and **circumcision** later practised. In occluded meatus the obstruction should be **cut**. In retention after catheterization the patient should be put to **bed** and **hexamethylenamine**, **laxatives**, and **diaphoretics** given. In obstruction due to spasm a **metal catheter** should be pressed gently against the contracted point until it passes. In fecal impaction the rectum should be emptied with a **spoon**. In retention due to bladder paresis or nervous disturbance a **rubber catheter** should be employed.

In chronic retention the treatment likewise differs according to the structures involved (see sections on Hypertrophy of the Prostate, Chronic Gonorrhea, Chronic Prostatitis, and Stricture of the Urethra, in this article; also **CYSTITIS**, vol. iii, **KIDNEYS, DISEASES OF**, and **KIDNEYS AND URETERS, SURGICAL DISEASES OF**, vol. vi, etc.).

In the **atony of the bladder** resulting from acute or chronic overdistention (or from senility), the treatment should consist of **systematic catheterization** according to the amount of residual urine, as in hypertrophy of the prostate (*q. v.*), together with occasional bladder washings

with warm boric acid solution, faradic electricity, and the internal administration of strychnine and ergot.

RUPTURE OF THE BLADDER.

—This is usually the result of traumatism. The common causes are a forcible blow in the hypogastrium and fracture of the pelvis when the bladder is full. Falls upon the buttocks or feet, heavy lifting, and straining at stool are also possible exciting causes. Rupture from overdistention is very rare, and usually occurs in cases of obstruction due to prostatic enlargement. Drunkenness, ulceration, or degeneration of the bladder, and cystitis are also predisposing causes. The accident is rare in children. The tear may involve that portion of the bladder-wall covered by peritoneum, in which case the lesion is said to be *intraperitoneal*; if not, it is described as *extraperitoneal*. Intraperitoneal ruptures result from the different forms of traumatism, excepting fractures of the pelvis, and constitute about four-fifths of the whole number. The extraperitoneal cases comprise chiefly fractures of the pelvis and rupture from overdistention. Many of the ruptures take place on the anterior aspect of the organ, and many others in the vicinity of the bladder-neck. Ruptures at the lateral aspects or base are usually intraperitoneal.

Symptoms and Diagnosis.—The symptoms vary according to the nature of the accident, and may be indefinite or absent for a time. Severe pain and a tearing sensation are often experienced, however, at the time of injury. In intraperitoneal rupture the patient displays more or less profound shock, persistent severe hypogastric pain, a desire to urinate—usu-

ally with inability to do so—and great difficulty in walking. If a catheter be carefully introduced, a little blood or blood-stained urine may escape, or nothing at all. If now a measured amount (a few ounces) of boric acid solution be slowly introduced, there will be no or only a partial return flow. This test, if positive, is diagnostic of rupture of the bladder, but a copious return does not exclude rupture, as if the latter is of limited extent or valvular all the fluid may be recovered. Symptoms of peritonitis may develop speedily or be delayed several days, depending on the condition of the urine.

Extraperitoneal ruptures—those involving the base—are accompanied by less shock, unless there be other injuries. Rigidity and tenderness of the hypogastrium are noted, and later a doughy infiltration of the space of Retzius may be palpable. Tenderness and infiltration may, in some cases, be noticeable on rectal palpation. The rent in the bladder in extraperitoneal cases communicates with cellular tissue, but not with any cavity; so that the bladder does not empty itself as completely as in intraperitoneal rupture. The urine, however, and any boric acid solution used, will return through the catheter more or less blood-tinged. The escape of urine in the tissues gives rise to a cellulitis, manifested by pain and fullness locally, and by fever and the usual constitutional symptoms of a severe local inflammation. Extensive infiltration of the scrotum, perineum, thighs, abdomen, and even the back may occur.

The injection test, whether of boric acid solution or air, is condemned by some in acute cases on the ground

that it tends to spread infection and increase shock.

Where the diagnosis remains in doubt, the prevesical space should be examined for extraperitoneal rupture through a suprapubic incision, before the peritoneum is opened for deeper exploration.

Rupture of the bladder is always a very serious accident. While the intraperitoneal variety in untreated cases shows a somewhat higher mortality than the extraperitoneal, nearly all cases die. Of 37 operated extraperitoneal cases, 35.1 per cent. recovered (Mitchell); of 34 intraperitoneal cases, 41.5 per cent. (Sieur).

Treatment.—Intraperitoneal rupture indicates immediate laparotomy, as the condition is otherwise certainly fatal either from peritonitis or from absorption of the urine, even if sterile. The rent in the bladder should be sewn up after the Czerny-Lembert method of intestinal suture, the peritoneum also sutured, and the efficacy of the suture line against leakage tested by running in salt solution until the bladder is filled. The wound should then be closed, a gauze wick being inserted, however, for drainage from the site of rupture. A catheter should be retained for a week or ten days while the wound is healing.

Extraperitoneal ruptures, if inaccessible, may be treated by the permanent catheter. In such cases irritations of the bladder and careful examination should be made from day to day for appearances of extravasation and inflammation either in the space of Retzius or in the perineum. Digital exploration of the rectum will reveal any collection in the pelvis. Such evidence calls for immediate, free incision. In the cases in which

the ruptured point is exposed in exploration, the opening should be sutured and tested, and drainage through the external wound provided for.

Wounds and contusions of the bladder not involving rupture are discussed in the article on ABDOMINAL INJURIES, volume i.

CYSTOCELE.—Partial hernia of the bladder in the male occurs in from 1 to 3 per cent. of all inguinal hernias. The organ may also be involved in a femoral, abdominal, perineal, or ischiatic hernia. In inguinal hernia the bladder is extraperitoneal in the great majority of instances, and the hernia is usually of the direct variety in these cases. The diagnosis of cystocele, which may be reached with the sound, is seldom made before the radical hernia operation. If the organ be cut into, it should be closed with Lembert sutures, and permanent catheterization instituted at the close of the operation.

Cystocele in women is a common sequel of extensive perineal laceration during parturition and is usually accompanied by prolapse of the uterus. Frequency of urination and dysuria are the chief symptoms, and cystitis and trabeculated bladder are possible sequelae. These patients sometimes find it necessary to push the prolapsed bladder forward and upward in urinating.

Treatment.—Some relief may be afforded by the introduction of a suitable pessary. Surgical correction of the displacement, in common with that of the uterus, is, however, to be preferred. (See PREGNANCY AND PARTURITION, DISORDERS OF, vol. vii, and UTERUS, DISEASES OF, in this volume.)

FOREIGN BODIES IN THE BLADDER.—Foreign bodies other than vesical or renal calculi include a large variety of articles introduced in the urethra from morbid sexual motives and accidentally slipping out of reach, e.g., pencils, glass tubes, twigs, pipestems, stones, etc. Portions of catheters or bougies, missiles, teeth and hair from a ruptured dermoid cyst, and seeds or bone entering through a fistula may also reach the bladder.

Symptoms.—Foreign bodies may occasion no symptoms for a prolonged period, or pain and signs of cystitis may soon develop. There is a tendency to stone formation around any vesical foreign body, and the symptoms of stone are sometimes those which lead the subject to the surgeon.

Diagnosis.—This is made from the history or by cystoscopy. In cases of unaccountable cystitis the possibility of a known foreign body concealed from the surgeon because of shame should come to mind.

Treatment.—The probability of subsequent stone formation renders removal of foreign bodies, even if causing no disturbance at the time, advisable. Cystitis, if present, having been reduced by rest in bed and other measures for a few days, an attempt should be made to extract the foreign bodies with special forceps or a small lithotrite. If persistent efforts of this type prove fruitless, and in particular if the foreign body is of glass, removal through a suprapubic cystotomy opening should be effected.

VESICAL CALCULUS.—When certain of the solid constituents of urine are present in excess, a portion is thrown out of solution in the form of crystals. When a number of these become adherent, a small calculus is formed around which, as a nucleus, a stone of some size is gradually formed. A stone may form in the bladder primarily or may develop around a nucleus originating in the renal pelvis and passing into the bladder.

Vesical calculi are composed, in the order of frequency, of uric acid, the earthy phosphates, and calcium oxalate. Stones composed of carbonates, cystin, xanthin, and indigo are occasionally met with.

The great majority of calculi consist of uric acid. This form is usually oval, smooth, of moderate size, and brownish in color, and is soluble

in dilute potassium hydroxide solution and with effervescence in nitric acid. Uric acid calculi are met with largely among children of the poorer families, and in adult life chiefly, among "free livers." The probable cause in the former is food unsuited to the time of life. The use of milk is discontinued as soon as the child is able to take solid food. The nitrogenous elements, thus taken in beyond requirements, are excreted as uric acid and, being in excess, tend to form calculi. In the latter class, liberal indulgence in rich foods similarly furnishes an amount of nitrogen far in excess of needs.

Phosphatic (fusible) calculi occur in alkaline urine, and therefore especially after middle life. They are apt to be associated with hypertrophied prostate, the residual urine and ammoniacal decomposition furnishing all the conditions necessary for the formation of a phosphatic stone. They consist of magnesium-ammonium phosphate together with calcium phosphate. They may be of any size, sometimes weighing several ounces and less frequently a pound or two.

Calcium oxalate calculi, like the uric acid stones, originate, as a rule, in the renal pelvis. They do not attain a large size, and are commonly more or less round in outline and dark brown in color. They dissolve in hydrochloric acid. Their surface is often mammillated,—a "mulberry" calculus. These stones form in urine containing a free deposit of calcium oxalate crystals,—a condition termed *oxaluria*, which appears to be associated with disorders of digestion and assimilation, and also with certain forms of neurasthenia.

These different constituents are not

infrequently found in association. Calculi composed of alternate layers of uric acid and calcium oxalate are not uncommon, and either of these compounds, or even a mixed calculus, is very apt to form a nucleus for a phosphatic stone.

The causes of stone in the bladder have already been hinted at, inappropriate food and an excess of articles leading to elimination of uric acid or calcium oxalate being the potent factors. In the formation of phosphatic stones any obstruction to emptying of the bladder, chronic cystitis, and other causes of alkaline urine play an active rôle. According to Rainey and Ord, increased density of the urine and the presence of colloids in solution are essential factors, in addition to the excess of urinary salts, in stone formations. Considerably more than half of the vesical calculi are met with in patients under twenty years, uric acid stones being especially frequent at this period of life, and most cases are in males. This is probably accounted for by the much greater facility with which a minute calculus can escape through the much shorter and more dilatable female urethra. Stone in the bladder is more common in certain sections of the world than in others. In the negro race vesical calculus is rare.

SYMPTOMS.—Symptoms of stone are frequent urination, pain, and changes in the character of the urine. The frequency of micturition varies greatly in different cases. It is usually greater during the day, when the individual is active, than at night. The desire for micturition often appears suddenly and irresistibly. In some instances urination is attended by considerable tenesmus, especially

in children. Prolapse of the rectum or involuntary defecation from straining may result. Occasionally the stream of urine will be suddenly arrested by the stone rolling into the vesical neck; this symptom is rare in the old, the urethral orifice being often relatively high. The pain may be constant or paroxysmal, or both. As a rule, there is sharp, burning pain toward the end of micturition, either hypogastric or just behind the glans; the pain then tends to disappear gradually as the bladder fills with urine. (In prostatic hypertrophy pain precedes, and stricture of the urethra accompanies, urination). Sometimes there is a constant dull ache in the hypogastric region, especially in patients subjected to constant jarring, *e.g.*, trainmen and those who drive over rough roads. The pain, like the frequency of urination, is increased by activity and lessened by rest. Its severity depends in a considerable degree on the roughness of the stone surface. Marked prostatic hypertrophy and encystment of the stone reduce the pain. Acute paroxysms ("attacks" or "fits of stone"), during which the symptoms are much worse, occur at intervals as a result of an acute infection or some unusual exertion.

The urine is apt to contain traces of the material of the stone, the microscope showing either uric acid, calcium oxalate, or phosphates.

The presence of a stone usually leads to hematuria, generally very slight and not apparent to the naked eye. After exercise, the last part of the urine passed at micturition may be tinted with blood. In cases of long standing or with cystitis, more or less pus will be present. Bleeding from

the urethra between acts of urination is evidence against vesical calculus.

Priapism and a tendency to exert traction on the prepuce have occasionally been observed in children, and in many cases various reflex pains are present.

A history of renal colic, chronic cystitis, or the introduction of foreign material into the bladder may be obtained.

DIAGNOSIS.—The actual presence of a stone in the bladder is determined by a vesical sound or stone-searcher. This instrument has a shaft rather longer than the urethral bougie and a shorter curve. It should not be larger than about No. 13 French. The patient should be recumbent, preferably with the pelvis raised. It is desirable to have some urine in the bladder or, in the absence of this, to inject about 100 c.c. ($3\frac{1}{2}$ ounces) warm sterile boric acid solution, attention being paid to every detail of antisepsis. When the instrument, previously lubricated, has been introduced, its toe is turned downward and each portion of the bladder systematically examined. The presence of a stone is indicated by the sensation imparted through the instrument to the hands of the surgeon, but especially by an audible "click" produced by gently striking the stone with the end of the instrument. The diagnosis should be made solely upon the latter sign, as a ribbed bladder, especially with phosphatic crusting, may give to the sense of touch the evidence of the presence of this stone.

Failure of the searcher to detect a stone does not absolutely prove its absence, as it may be fixed in a diverticulum or ureter, or in a sac back of the prostate. In case of doubt (or in

the first instance) cystoscopy may be availed of. The X-rays may be of use in the diagnosis of vesical calculus.

TREATMENT.—While a stone may exist in the bladder for a long period without causing much irritation, sooner or later there will be cystitis, and probably infection of the kidneys. Therefore, if the patient's health will at all permit, a vesical calculus should be removed as soon as possible after its detection. Efforts to dissolve the stone either by internal medication or by irrigation are not to be recommended. Two methods are available for its removal, viz., litholapaxy and lithotomy.

Litholapaxy is to be recommended in the vast majority of cases. In children below four years of age, however, it is often impossible to introduce an evacuating catheter of sufficient size to carry out the fragments. Above this age, with proper instruments, litholapaxy is just as safe and satisfactory as in the adult. Keegan has performed litholapaxy with success in numerous small children, some below two years of age; his mortality, however, has been 4.3 per cent. in these cases. If there is a stricture, it will usually be possible to treat it preparatory to operating for the stone. Occasionally prostatic hypertrophy interferes with the introduction of the lithotrite or the evacuating tubes, and thus prohibits this operation. In suitable cases White recommended **vasectomy** and, after the prostate had undergone sufficient atrophy, to proceed with the litholapaxy. Or, **suprapubic lithotomy** and **prostatectomy** in 1 or 2 stages may be practised.

Cystitis is not usually a contraindication, as it can be treated beforehand

by **urinary antiseptics internally and bladder irrigations**. In cases with an obstinate ammoniacal cystitis, however, or with a severe pyelonephritis or prostatic abscess, requiring good drainage, **perineal or suprapubic lithotomy** may be preferable.

The advantages of litholapaxy are its safety (in experienced hands), the avoidance of a wound, and the short convalescence, uncomplicated cases leaving the house in from two to five days after the operation. A cutting operation confines the patient to bed for some weeks, and there is always some danger of a urinary fistula remaining.

Lithotomy.—Cases occur in which the crushing operation is inappropriate. In addition to the contraindications already mentioned, if it is suspected that the nucleus of the stone is a foreign body of any kind, introduced into the bladder by accident or otherwise, it will be necessary to perform lithotomy. In rare instances also it is impossible to crush the stone because of its hardness or its large size.

In cutting for stone the bladder may be approached either suprapubically or through the perineum. For removing stones more than 1½ inches in diameter and for inspecting the bladder if any such indication exists, the suprapubic method should be selected. For smaller calculi many prefer the perineal incision. Others, however, open the bladder above the pubes in every case. If the bladder-walls are healthy, it is often possible satisfactorily to unite the bladder incisions by sutures in the suprapubic operation, thus overcoming one of the serious objections to perineal lithotomy.

Before subjecting a patient to any operation for stone in the bladder **phenyl salicylate** or **boric acid** in doses of 10 grains (0.6 Gm.) 3 or 4 times a day should be given for a few days; or, **hexamethylenamine** or **urotropin** in a dosage of from 20 to 30 grains (1.3 to 2 Gm.) in twenty-four hours, may be used. In cases complicated by marked cystitis,

especially before litholapaxy, it is also advisable to practise **irrigation of the bladder** 2 or 3 times daily for a few days before operation. A diet chiefly of milk and more or less **absolute rest** for a few days also add to the success of the operation. A **purgative** should be given on the day preceding the operation. If a cutting operation is proposed, the parts should be cleanly shaved and prepared as for other operations. All of the instruments and other articles to be used should be as carefully sterilized as for any other operation.

Technique of Litholapaxy.—The instruments required for this operation are a lithotrite, evacuator, evacuating catheters, ordinary catheters of different kinds, a vesical sound, warm boric acid solution, a syringe for irrigating the bladder, and suitable receptacles. A basin or jar with three or four thicknesses of gauze secured over the top should be prepared to receive the stone. One should have at hand instruments for lithotomy in the event that litholapaxy should fail for any reason.

Of the **lithotrites** upon the market the two chief forms are those of **Bigelow** and of **Weiss**. Either will be found entirely satisfactory. For children a special instrument has been designed by Weiss. Of the various forms of **evacuators**, that designed by **Bigelow** is perhaps the most satisfactory. It should be fitted with several evacuating catheters of different sizes.

Before the operation the penis and prepuce should be well disinfected with **green soap** and **mercury bichloride** solution, and thorough irrigation of the anterior urethra practised.

Ether having been administered, the first step should always be the introduction of the **stone-searcher**, to be certain that the stone is still in the bladder. Unless the surgeon can demonstrate its presence by sound to at least one person besides himself, it should be the rule to abandon the operation. In such an event, subsequent examinations may be made and the subsequent course decided accordingly. If the stone is detected, the next step should be to introduce a suitable lubricated catheter and withdraw the urine. The bladder should then be irrigated with warm **boric acid solution**—10 to 15 grains (0.6 to 1

Gm.) to the ounce (30 c.c.) of sterile water—until the fluid returns clear. A quantity of the solution should now be introduced and allowed to remain, the catheter being withdrawn. In the adult this quantity may be about 6 fluidounces (180 c.c.); for a child, 2 or 3 ounces (60 to 90 c.c.). The patient should be in the supine position, with the legs extended but slightly separated.

The lithotrite is next lubricated and carefully introduced into the bladder. A right-handed surgeon may introduce it while standing to the patient's left, but should then pass to the right side of the patient for the subsequent manipulations. The instrument, having been introduced, should be moved back and forth slightly to see that it is free, and the beak then turned toward the base of the bladder. The ratchet which binds the two blades should be released and the jaws separated 1 or 2 inches and again brought together. If the stone is not caught the manipulation is repeated, shifting the points in order to sweep the different portions of the base of the bladder. When the stone is caught, the blades are held firmly together and locked, after which the instrument is revolved until the beak points anteriorly, when the stone is crushed by screwing down the handle. The blades are then released, turned again toward the base of the bladder, another fragment picked up, turned forward, and crushed as before. This procedure is continued until the instrument fails to seize any fragments too large to be withdrawn through the evacuating tube. The blades of the instrument are then tightly closed and locked, after which it is withdrawn.

The largest evacuating catheter that will pass easily should now be introduced, care being taken to prevent any of the fluid from escaping from the bladder, and the evacuator—previously filled with **warm boric acid solution**—attached. By alternately compressing and relaxing the bulb the fragments will be drawn into the latter and fall into the glass receptacle below. This should be continued until no more fragments are brought out. If bleeding from the bladder colors the boric solution deeply, the bulb may be emptied and refilled, the stop-cock on the outer end of

the catheter being closed meantime to prevent escape of fluid. If during evacuation of the fragments a click is repeatedly heard as the bulb is relaxed, a fragment remains which is too large to pass through the eye of the catheter, and the lithotrite will have to be reintroduced to reduce it. When the bladder appears empty of fragments the stone-searcher should be again introduced, and if any portion of the stone remains it should be crushed and removed. It is undesirable, however, to reintroduce the lithotrite oftener than absolutely necessary; the crushing process should be carefully carried out, and as far as can be determined, fully accomplished before withdrawing the instrument. Finally, the bladder should again be irrigated with **warm boric acid solution** until the fluid returns clear, when 2 or 3 ounces (60 to 90 c.c.) may be introduced and allowed to remain. The patient is then returned to his bed, and, if the operation has been a long one, **external heat** applied and **hot compresses** placed over the **hypogastrium**. The **urinary antiseptic** should be continued and the diet restricted to milk for two or three days, until it is evident that convalescence is assured. Patients otherwise healthy and who do well may be allowed out of bed on the second or third day.

Clogging of the lithotrite during operation is impossible with the modern fenestrated instruments. Unusually hard stones can generally be dealt with by means of the Chismore lithotrite, which is provided with an automatic hammer.

Unduly rough litholapaxy may be followed by retention of urine, excessive hemorrhage, cystitis, urethral fever, prostatic abscess, epididymitis, and even pyelonephritis. Prostatic catarrh may follow even expert litholapaxy.

Cystoscopy should, if possible, be practised one month after litholapaxy to make sure that no fragment of stone has been left behind.

Technique of Lithotomy.—In general, in adults the **perineal** route should be selected under the following circumstances: (1) In cases of deep urethral stricture rebellious to dilatation, in which, using the median method, the stricture may be divided at the same time. (2) In cases of stone of moderate size and of such hardness and

density as to make too great demands on the strength of the lithotrite or of the operator. This condition occurs very rarely.

(3) In cases of atony of the bladder, with little or no expulsive power, where there is already a chronic cystitis, and where the stone is of medium size.

Suprapubic lithotomy should be selected:

(1) when the stone is unusually large, and also believed to be of exceptional hardness; (2) in cases of marked prostatic hypertrophy with pouched bladder, chronic cystitis, and large stone; and (3) sometimes when the kidneys are diseased. In children too young to permit of introduction of the litholapaxy instruments, the lateral perineal operation is the method of choice.

PERINEAL LITHOTOMY.—*Lateral*.—The instruments required are a grooved staff, lithotomy knife, probe-pointed bistoury, lithotomy forceps, lithotomy scoop, a large-sized pure-rubber catheter, a catheter *en chemise*, hemostatic forceps, scissors, ligatures, and sutures.

The patient having been etherized, the vesical sound is introduced and, if the stone is detected, the operation proceeded with. The urine is withdrawn, the bladder irrigated with warm boric acid solution, 6 or 8 fluidounces being allowed to remain. The patient is then so arranged that the buttocks project slightly from the end of the table; the thighs are flexed upon the abdomen and the legs upon the thighs and retained in this position by assistants or a Clover crutch. The grooved staff is then introduced and placed in proper position by the surgeon, after which it is held accurately in this position by an assistant. The handle should be held either perpendicularly or inclined slightly toward the patient's right groin, and should be drawn well upward so that the curve rests against the under surface of the symphysis pubis. The surgeon should then fix in his mind the central point of the perineum, which is midway between the anus and the perineoscrotal junction, and in the adult is about 1½ inches in front of the former. Finally observing that the staff remains in proper position, a lithotomy knife is introduced vertically in the direction of the staff at the central point of the perineum, just to

the left of the *raphé*, and carried downward and outward across the left ischio-rectal space, terminating on a line between the anus and the left ischial tuberosity, rather nearer to the latter than the former. This incision is deepest at the beginning and becomes shallower at the posterior extremity. It passes through the skin, superficial fascia, transverse perineal muscle, nerve, and vessels, the lower edge of the anterior layer of the triangular ligament, and the inferior hemorrhoidal vessels and nerves.

The surgeon then introduces the left index finger into the wound, and locates the groove of the staff. The knife is now passed along the finger and made to engage in the groove, after which it is pushed along toward the bladder, being careful not to allow it to escape from the guide until the gush of fluid indicates that the bladder has been reached, when it is made to cut downward and outward in the line of the first incision. This divides the membranous and prostatic portions of the urethra, the compressor-urethræ muscle, the posterior layer of the triangular ligament, a few fibers of the levator-ani muscle, and the left lobe of the prostate. The left forefinger should then be introduced into the bladder, using the staff as a guide, and when the stone is felt the staff withdrawn, the lithotomy forceps introduced along the finger and made to seize the calculus, which is then extracted.

In children, in whom it is desirable to operate through as small an incision as possible, the lithotomy forceps may be introduced along the groove of the staff and the stone extracted without introducing the finger at all. Little difficulty is experienced in finding the stone in children, as there is no pouching of the bladder. Occasionally the stone is found too large to be extracted through the incision; it may then be broken into 2 or more fragments with a lithotrite introduced through the wound. It is desirable to extract a stone without fragmentation when possible, but this should not be done at the risk of injuring important neighboring structures. Finally, the bladder is explored to make sure that other calculi do not exist, the wound inspected for any bleeding vessels to be tied, a large rubber catheter intro-

duced, the bladder irrigated, and a little iodoform gauze laid in the superficial portion of the wound around the catheter,—which should be held in place by sewing to the edge of the incision,—and a dressing and T-bandage applied.

Usually the hemorrhage following the incision subsides after the patient's legs are brought together. If pronounced bleeding continues from the deep portion of the wound, it is best controlled by introducing a catheter *en chemise*, made by passing the end of a large rubber catheter for about 2 inches through the center of 4 layers of sterile gauze about 8 inches square and fixing the gauze in this position by tying firmly with silk thread. This is then introduced into the wound and gauze packing placed firmly and evenly around the catheter and inside the gauze.

The patient's knees should be bent over pillows, the scrotum elevated, and the linen under the patient changed when it becomes wet. The catheter tube may be taken out in forty-eight hours. By the eighth to the twelfth day urinary flow through the urethra will return. In children no catheter tube is required.

Occasionally when the artery of the bulb has been divided, hemorrhage is so free as to demand a ligature or the application of pressure forceps, which may be allowed to remain one or two days. The internal pudic artery has been wounded by carrying the incision too far outward toward the tuberosity of the ischium; bleeding from this source may be similarly arrested. The rectum has also been wounded by carrying the incision too far inward and failing to keep the blade of the knife sufficiently lateralized; usually the rectal wound heals spontaneously.

Median perineal lithotomy is performed through an incision directly in the midline of the perineum. The patient is placed in the same position as for lateral lithotomy, and the staff introduced, held vertically, and drawn well up under the pubes. The left index finger is introduced into the rectum and the groove of the staff located at the apex of the prostate. A knife with a double cutting edge at the point and a cutting edge of about 3 inches on one side is introduced with the long cutting surface upward 1 inch in front of

the anus and directed to the groove in the staff at the point located by the finger. When the point of the knife has reached the groove of the staff, it is pushed onward toward the bladder, so as to incise the apex of the prostate and then withdrawn, cutting upward for $\frac{3}{4}$ to 1 inch. A probe-pointed grooved director may then be passed into the bladder on the groove of the staff, to be used as a guide for introduction of the finger or lithotomy forceps. There is comparatively little hemorrhage, but the operation provides only a very limited space in which to work, and is therefore suitable for calculi of the smallest size only. The incision also approaches closely to the bulb anteriorly and the rectum posteriorly, either of which may be injured if the knife is carried slightly beyond the limits mentioned.

Perineal lithotomy has gradually been losing in popularity in favor of suprapubic lithotomy, which, in adults at least, yields a distinctly smaller mortality.

SUPRAPUBIC LITHOTOMY.—The instruments required include scalpels, dissecting forceps, hemostats, retractors, rectal bag, lithotomy forceps, lithotomy scoop, catheters, syringe, stone-searcher, scissors, needles, and sutures.

The preparation of the patient has already been described. After anesthesia the presence of the stone should be determined before proceeding. The next step is the introduction of the rectal bag, previously oiled, well above the internal sphincter. A catheter is then introduced, the urine withdrawn, and the bladder irrigated with warm boric acid solution, from 6 to 10 ounces (180 to 300 c.c.) being allowed to remain. A catheter or rubber tube should be tied round the penis to prevent expulsion of the solution. From 8 to 10 ounces (240 to 300 c.c.) of boric solution should then be injected into the rectal bag and retained. In children the quantities of fluid in the bladder and rectal bag should be much smaller; or, owing to the higher position of the bladder, the rectal bag may be dispensed with altogether.

The incision should begin in the midline about $\frac{1}{2}$ inch below the symphysis pubis, and in the adult may be carried upward about 3 inches. The incision is care-

fully deepened, either between the muscles or through them, until the transversalis fascia is reached. This being divided, the prevesical fat and connective tissue are exposed. It is desirable to reach the bladder by blunt dissection from this point, pushing upward the fat and connective tissue, which often contain a number of large veins, with the finger and scalpel handle; this also raises the peritoneum out of danger. The peritoneal reflexion may be abnormally low in any case, and may be opened if due caution is not observed.

The bladder having been exposed, all bleeding should be controlled by pressure-forceps, the bladder-wall transfixed with a sharp hook, and a scalpel thrust vertically into the bladder, cutting downward toward the symphysis. The edges of the bladder-opening may then be caught with tenacula or transfixed with needles carrying strong silk threads. The forefinger may now be introduced, and the stone located and removed with forceps. Making certain that the bladder is empty, if the walls are in a healthy condition, one may close the incision with chromicized catgut sutures. These should be passed close together and include all the coats except the mucous membrane. The abdominal wound is closed by suturing, a small drainage-tube being introduced through the external wound and retained until it is certain that the bladder incision is going to heal kindly. A catheter should be introduced through the urethra and retained for a week or ten days.

If the bladder-walls are unhealthy or there is pronounced cystitis, so that immediate suture is unsafe, the margins of the bladder-wound may be united by a few stitches to the deeper portion of the abdominal incision and a large drainage-tube introduced. **Siphon drainage** by means of a long tube reaching to a bucket on the floor, with or without an attached receptacle above containing fluid, is here very useful in preventing the urine from saturating the dressings and excoriating the skin. The bladder should be frequently irrigated and the skin around the wound cleansed and protected with an antiseptic ointment. As soon as the condition permits, the external drainage should be removed and the wound allowed to close.

TUBERCULOSIS OF THE BLADDER.—The majority of cases of tuberculosis of the bladder occur before the fortieth year. It is nearly always secondary to deposits elsewhere, but occasionally seems to be primary. Many of the secondary cases follow tuberculosis of the kidney or an ascending infection from the epididymis. More rarely there is direct extension from the prostate or seminal vesicles.

Symptoms.—These develop insidiously. Advice is rarely sought until the disease has lasted for some time. The onset of symptoms may be induced by urethral instrumentation. The earliest manifestation is either increased frequency of urination or hematuria. The latter is characteristically a terminal hematuria, *i.e.*, is most marked at the end of urination, and is never very profuse, but when once established tends to persist for some time, the urine showing at least a light, microscopic sediment of red cells. The bleeding occurs both day and night, and different from that of stone, is unaffected by exercise or jolting. Pain generally follows sooner or later. It is mild in some cases and severe in others; deposits at the neck of the bladder always cause considerable pain. At first the pain, felt in the penis and perineum, occurs only at the close of urination; later, when mixed infection has supervened or ulcers developed, it is also experienced before urination. Pus and blood in the urine are merely the result of the ulcerating process, and not of the tuberculosis *per se*. Cystitis develops sooner or later, the pain, frequency of urination, and tenesmus being then much increased.

A characteristic feature is that the

urine remains persistently acid, even after mixed infection has been established. The finding of casts in the urine suggests renal involvement.

Diagnosis.—There is nothing peculiar about the symptomatology. The diagnosis must rest upon the detection of tubercle bacilli in the urine of a person who has the symptoms of chronic cystitis, and upon cystoscopy. Even if bacilli are found, one is often unable to determine whether they emanate from the kidney or the bladder, except by urethral catheterization. Again, bacilli are not detected in some cases of genuine vesical tuberculosis. It is possible to have renal tuberculosis in conjunction with a non-tuberculous cystitis. The diagnosis will usually be made (1) by excluding the common causes of cystitis—gonorrhea, vesical calculus, urethral stricture, and hypertrophied prostate—by the usual methods of detecting these conditions, and (2) by noting the evidences of marked cystitis with tubercle bacilli in the urine and without symptoms referable to the kidney. A tuberculous family history or the presence of a tuberculous lesion elsewhere, *e.g.*, in the testicles, prostate, or lungs, would point to a similar condition in the bladder. Repeated examinations should be made before deciding that tubercle bacilli are absent.

Cystoscopy is likely to yield valuable evidence, either by showing the presence of a tuberculous process or by establishing its absence. If the disease is present, groups of minute whitish tubercles with surrounding zones of congestion, or tuberculous ulcers, round, relatively small, with an uneven, yellowish floor and elevated, slightly undermined edges

(Coplin), may be discovered. Concentration of the lesions about the ureters if the disease has been primary in the kidneys, or about the trigone, if primary in the prostate, may be noted. The mucous membrane as a whole may appear red and velvety. Where no cause can be found in the bladder, it is well to catheterize the ureters separately to locate the seat of the disease.

Treatment.—In the early stages, if it is possible to build the patient's health up by generous feeding, tonics, suitable climate, etc., the disease may be arrested and healing follow. The urine should be kept as healthy as possible with a urinary antiseptic and by the free use of milk and water. Creosote, balsamics, and alkalis may all be of value. In early cases local treatment is to be avoided. Later the gentle introduction of a small quantity of a 10 per cent. mixture of iodoform in sterilized olive-oil or glycerin every few days may be tried. It may be preceded by irrigation of the bladder, but if any evidences of irritation follow, this should not be repeated. Irrigations of bichloride of mercury, beginning with 1:5000, are highly extolled by Guyon. For relieving vesical spasm, Keyes has found mercury bichloride, guaiacol valerianate, and thallin most useful. The first is instilled daily in 2- to 10- minim (0.12 to 0.6 c.c.) amounts of a very dilute solution, at first 1:25,000, then increased according to tolerance. Guaiacol valerianate is used in 25 to 100 per cent. solutions in olive oil, and thallin sulphate 3 to 12 per cent. aqueous solutions, 2 or 3 times weekly. For frequent pain, tenesmus, and urination, suppositories of opium and belladonna may be used.

When the pain and frequency of urination become unbearable and fail to respond to treatment, it will be necessary to perform **suprapubic cystotomy** for the purpose of drainage. At the same time it is occasionally possible to remove the disease, if superficial, with **curette, knife, or cautery**. The rest afforded by **prolonged drainage of the bladder** is one of the most potent therapeutic factors. In some instances good results, and even cure, are obtained by **irrigating the bladder** through the cystotomy wound with **iodoform, bichloride, or guaiacol solutions**. It is always difficult to decide when the suprapubic opening may be allowed to close in cases that progress favorably. In general, this should not be until the evidences of cystitis have disappeared.

TUMORS OF THE BLADDER.

—**Varieties.**—Most bladder tumors are at first papillomatous, later undergoing malignant degeneration. Much less frequent are fibromatous and myxomatous polypi, sarcoma, mixed tumors, adenoma, myoma, angioma, chondroma, nevus, and cysts, the latter dermoid, hydatid, or epithelial. A condition of epidermization of the bladder analogous to leukoplakia of the tongue, resulting from protracted chronic inflammation, has also been observed.

Symptoms.—Benign tumors of the bladder often produce no symptom but hemorrhage, seldom causing bladder irritation or cystitis. In malignant growths hematuria is likewise the chief symptom, which, however, is sooner or later accompanied by pain and difficulty of urination and signs of cystitis. The hemorrhage of bladder tumor is typically spontane-

ous, painless, and profuse. It is practically uninfluenced by rest or drugs, and may be continuous or typically cease spontaneously. If there be any relationship of the hemorrhage to micturition, it tends to occur at the termination of the act. The urine contains blood-clots and, in malignant cases, pus, mucus, and at times fragments of tumor. Only occasionally is hemorrhage not the initial symptom, being preceded by pain and dysuria, frequent urination or cystitis.

The pain in malignant cases may be lancinating and very severe. Pain may also arise from cystitis, the passage of blood-clots, or urethral obstruction. In some instances acute or chronic retention of urine occurs, from obstruction either by a blood-clot or the growth itself. Cystitis, once established, is manifest in a peculiarly severe form, and, unless the inflamed tumor be removed, is likely eventually to extend to the kidneys.

Etiology and Pathology.—Bladder tumors constitute about 4 per cent. of all cases of genitourinary disorder in the male. In the female they occur only one-fifth to one-half as frequently as in men. They are met with usually in the elderly, though the rare sarcomatous and myxomatous tumors are peculiar to the young. Carcinoma is by far the commonest bladder growth, occurring about 5 times as often as papilloma, which comes next, and about 30 times as often as myxoma.

About one-third of all bladder tumors are multiple. They almost always start at the base of the organ, generally in the vicinity of the ureteral openings, less often near the neck of the bladder. The papillomatous growths consist of a series of

delicate, finger-like masses which float out in the urinary fluid like marine plants, and are provided with definite pedicles. Microscopic examination of the base of the growth sometimes reveals a carcinomatous structure; but even the ordinary papilloma often has malignant proclivities, tending to recur unless removed early and inoculating itself into adjacent tissues by mere contact.

Carcinomas other than those originating in papilloma are in the majority of cases secondary to cancer of the rectum, prostate, or uterus. The primary carcinomas are sessile, fungating, ulcerating growths, which penetrate deeply in the thickness of the bladder-wall and spread by infiltration as well as by contact. Metastasis occurs to the iliac lymph-glands and later to the lumbar glands. Malignant tumors of the bladder, as a whole, progress far more slowly, however, than cancer of the prostate, and produce death by cystitis and ascending infection rather than by carcinosis.

Sarcoma of the bladder may be of one of a variety of simple or mixed types, and is a sessile or infiltrating growth. It progresses rapidly.

Diagnosis.—Hemorrhage which is copious, little or not influenced by exercise, painless, associated with the passage of large clots, and which may be brought on by the insertion of a catheter or other instrument, is strongly suggestive of a vesical growth. Pieces of growth easily mistaken for blood-clots are likely to be passed where there is papillomatous tissue; or, groups of cancer cells or pieces of a fibroma may be found; otherwise the urine offers little that is diagnostic. Non-ulcerated and non-

villous tumors may cause no hemorrhage. Bimanual examination with a finger in the rectum will reveal the tumor if distinct infiltration of the base of the organ has already occurred, but papillomas or small sessile growths will not be detected; such examination will, in addition, exclude general hypertrophy of the prostate.

Cystoscopy with the irrigating instrument, care being taken to examine minutely each surface of the bladder for growths in order that none may be overlooked at operation, is the chief procedure in positive diagnosis. If necessary, general anesthesia may be induced for the special purpose of cystoscopy. Where the latter is entirely impracticable, some direct information may be gained by the use of a stone searcher if the growth be large or hard or if it can be readily made to bleed, the latter observation suggesting papillæ. Suprapubic cystotomy may also be performed, with the additional intention of excising the tumor if any exists.

Prognosis.—Any untreated bladder growth finally proves fatal, owing to the infection sooner or later superadded. Papilloma always turns eventually into carcinoma. Before cystitis sets in the general health may remain good in spite of the hemorrhages. When the infection does occur, the health is more rapidly undermined. Yet the patient with bladder carcinoma is likely to live several years.

Treatment.—Early surgical removal of bladder tumors is, unless the condition be already an inoperable one, always indicated. If cystitis does not yet exist, great care should be taken not to infect the bladder before the

operation is carried out. **Urinary antiseptics** should be given for prophylactic purposes. If hemorrhage is troublesome the patient may be put to bed and **alum** in the form of Squibb's Surgical Powder, a heaping teaspoonful suspended in 500 c.c. (1 pint) of hot water (Keyes), injected into the bladder. A hot solution of **gelatin**, or a dilute solution of **silver nitrate**, or one of **antipyrin**, may be substituted. For the evacuation of clots Keyes recommends irrigations through a large woven catheter or repeated irrigations and **aspirations** with the **Bigelow evacuator** (see section on Stone in the Bladder).

For the elimination of papillomatous bladder growths the **high-frequency current (fulguration)** has been highly recommended. Where this method is not availed of, if the growth is a papilloma or benign tumor, **removal** through a **suprapubic incision**, followed by **cauterization** of the base of the tumor, is the procedure of choice.

Where, however, the growth is sessile or infiltrating, this method is inadequate, and must be replaced, when the growth is situated high up or laterally, by resection of the portion of the bladder bearing the growth. When, as is usually the case, the tumor is at the base of the bladder, such **partial resection** becomes exceedingly arduous, the **ureters**, nearly always involved, having to be cut off and **transplanted** into the remaining part of the bladder, and preservation of the function of the urethra being also necessary. In many instances **total cystectomy**, though a most serious operation, is therefore preferred. This procedure should be preceded by **bilateral lumbar nephrostomy**; or the

ureters may be implanted in the rectum or vagina.

The mortality of total cystectomy being somewhat over 50 per cent., the operation is of relatively little value, and in such cases, as well as in those more advanced in which over one-third of the bladder is already involved in the tumor, a **palliative operation**, **suprapubic cystotomy**, is by many considered preferable. Often the tumor can simultaneously be removed in part with the knife or **curette**, and its base be carefully **cauterized**. Marked symptomatic relief is thus frequently obtained, though the operation is not a curative one. **Suprapubic cystotomy** is also an operation of last resort in obstinate bleeding and cystitis. Barringer and Schmitz (1918) have reported gratifying results from **radium** treatment in bladder carcinoma. According to the former, its effects are quite equal to those of surgery.

ULCER OF THE BLADDER.—Bladder ulcerations other than those arising from tuberculosis and malignant disease may occur from injury, simple cystitis, gonorrhea, or may very rarely be "idiopathic." The traumatic ulcers are due to injury by a stone in the bladder or to crushing of the bladder-wall during childbirth. According to L. E. Schmidt, gonorrhea, while usually manifest merely as a relatively mild inflammation of the trigone, occasionally causes a multiple ulceration attended with marked pain and hematuria. The same author finds a solitary, sharply defined ulcer common in anemic women, while Fenwick describes an idiopathic ulcer occurring usually between the ureteral orifice and the median line, and giving rise to symptoms similar to those of bladder tuberculosis, though benefited by irrigations. Hunner (1915) has described an obscure and painful form of ulcer occurring in the vertex or free portions of the bladder. It appears as a white, scar area beside a red spot, and requires excision.

Diagnosis.—The presence of bits of bladder-tissue, with blood and clots, in the urine indicates ulceration. In some kinds of ulcer cases, however, the urine may be limpid. A more definite diagnosis is reached by cystoscopy or exploratory suprapubic incision.

Treatment.—Antiseptic irrigations of the bladder may be practised, urinary antiseptics given internally, and the ulcers curetted through the operating cystoscope. In the anemic cases iron should be given. If the ulcers are extensive it may be advisable to curet through a suprapubic opening and drain. If perforation should occur, treatment as for rupture of the bladder (*q. v.*) should be instituted.

VARICOSE VEINS OF THE BLADDER.—This is an uncommon condition, manifesting itself in sudden copious hemorrhage from the bladder. The diagnosis has been made only by cystoscopy or an exploratory operation.

Treatment.—Cauterization or suture of the bleeding point after suprapubic cystotomy is required if the hemorrhage fails to stop of itself.

FISTULA OF THE BLADDER.—Among the most important varieties of fistula of the bladder is the *vesicointestinal* fistula. This is rarely congenital. The acquired type is usually a vesicorectal, less frequently a vesicosigmoid channel, and may be due to malignant disease, tuberculosis, ulceration of a sigmoid diverticulum, ulcer of the rectum, stone in the bladder, trauma, or one of various other causes. It is manifested in the passage of gas and later feces from the urethra, with resulting cystitis, and by the passage of urine through the anus. The diagnosis may be clinched and amplified by the ingestion of carmine, which will appear in the urine; by the injection of methylene blue into the bladder, the stain appearing in the feces; by the ingestion of a bismuth meal and subsequent X-ray examination; by cystoscopy, and, if the fistula enters the rectum, by the finger in the rectum or inspection through a rectal speculum.

Vesicovaginal, vesicouterine, and hypogastric fistulas are also met with.

Treatment.—In vesicointestinal fistula daily irrigation of the bowel and the bladder may, with advantage, be practised.

Surgical correction of the trouble may be tried by **celiotomy**; evacuation, clamping, and liberation of the loop of bowel adherent to the bladder; repair of the opening in the bowel, with or without excision of a diseased section, and closure of the bladder opening with mattress sutures, to be followed by **drainage** to the area of bladder suture, **continuous catheterization** and maintenance of a tube in the rectum for a few days. Where the condition is an incurable one, a **palliative colostomy** may be performed.

Vesicovaginal fistula is treated as described in the article on VAGINA AND VULVA, DISEASES OF, in this volume.

In vesicouterine fistula, **radical correction** consists in **dissecting out the fistulous tract** and suturing the surrounding tissues either through and through—exclusive of the vesical mucosa—or in layers. If all attempts of this type fail, the uterine cervix may be entirely closed up, after removal of its mucous membrane, while the fistula connecting with the uterus is allowed to remain.

In hypogastric fistula spontaneous firm closure will often take place eventually, provided **obstruction in the urethra** has been **overcome**. If such obstruction has been only in part relieved a **permanent catheter** in the urethra may greatly favor closure of the fistula. In cases persistently refractory, the fistulous tract should be **excised**, the bladder liberated from the parietes, and the opening in it closed with mattress reinforced by Lembert sutures. **Drainage** from the wound should be provided for and a catheter kept in the urethra to reduce strain on the bladder sutures and facilitate healing.

DISEASES OF THE SEMINAL VESICLES.

ANOMALIES of these organs are rare, and seldom unassociated with abnormalities of other genital organs. Absence of one vesicle has been recorded. Anomalies of the ejaculatory ducts sometimes occur, these ducts discharging at the external urinary meatus or into the ureters.

WOUNDS of the seminal vesicles are almost invariably operative, the ducts being often injured in perineal operations on the prostate or bladder. Obstruction of

these ducts, spermatic fistula, or seminal vesiculitis may result. Occlusion of a duct does not lead to dilatation of the corresponding vesicle.

CONCRETIONS not infrequently occur in the seminal vesicles in old men, and occasionally give rise to spermatic colic,—a sharp, colic-like pain felt chiefly near the anus or bladder-neck and occurring either at the orgasm or during sleep. The obstruction in the duct which causes it, viz., impacted concretion or dried semen, is often soon removed, though at times pain persists for a number of minutes.

Treatment.—The immediate treatment for spermatic colic is a **hot rectal douche** (see Treatment of Chronic Urethritis); enduring relief is obtained by **massage of the vesicle** concerned.

ACUTE SEMINAL VESICULITIS is usually a complication of acute gonococcal urethritis, but may also occur from infection with the common pyogenic organisms. Prostatitis always accompanies it.

Symptoms.—These may be lacking until suppuration begins, when painful and frequent micturition, very painful defecation, and pains in the anus and rectum, perineum, and hips or back are likely to be complained of. Priapism and bloody ejaculations may be noted. True abscess formation is rare.

Diagnosis.—The enlarged, tense, and tender vesicles are palpated from the rectum at the sides of and behind the prostate. (Normal vesicles are not palpable unless markedly distended.)

Treatment.—Local treatment of the coexisting gonococcal urethritis should be interrupted, and the treatment for acute prostatitis (*q. v.*) applied. In the rare cases in which abscess of the seminal vesicles develops and a tendency to extension or rupture in the rectum or ischio-

rectal fossa is noted, the abscess may open from the rectum or perineum.

CHRONIC SEMINAL VESICULITIS usually develops insidiously in subacute or chronic gonorrhea, but may follow acute vesiculitis. It is a frequent, but inconspicuous complication of prostatic hypertrophy. Chronic prostatitis always coexists.

Symptoms.—The symptoms greatly resemble those of chronic urethritis itself, including an irregular gleet discharge and frequent micturition. Disturbances in the sexual sphere are, however, likely to be more marked, sexual weakness, nocturnal emissions, and blood-stained semen being especially noted. A characteristic symptom is vesicular colic, experienced in the region of the vesicles and occurring spontaneously or induced by defecation, ejaculation, or erection. Keyes has observed cases of apparent typical renal colic due to and relieved by treatment of vesicular disease.

Diagnosis.—Rectal palpation may reveal dilatation or localized indurations of the vesicles. From protracted inflammation they may attain 2 or 3 times their ordinary size. If the expressed seminal secretion contains but little pus, it may be distinguishable from prostatic discharge in that most of it floats on urine while the prostatic secretion sinks. Since, however, the secretion of the inflamed vesicle, when examined, usually contains much pus, distinction between the two types of discharge is generally impracticable.

Treatment.—The coexisting posterior urethritis should be dealt with as usual. The chief direct measure is **massage of the vesicles**, which should be carried out even if these

organs appear normal on palpation. With the patient bending over the back of a chair, the surgeon's finger, covered with a lubricated finger-stall, is inserted in the rectum and carried as high as possible on one of the vesicles. Pressure is made at that point and the finger then drawn down slowly, either directly or by a zigzag route, until the prostate is encountered. If the vesicles are impalpable, 6 of these strokes on each side are sufficient; if tense or hard, additional strokes should be given until, preferably, the bulk of the vesicles has been manifestly reduced. **Massage of the prostate** is then usually superadded (see Chronic Prostatitis). The procedure may be carried out 2 or 3 times weekly, and should be followed by micturition and **antiseptic irrigation** of the urethra and bladder.

TUBERCULOSIS OF THE SEMINAL VESICLES.—This condition is believed to be usually preceded by tuberculosis of the prostate or testicle, but may be primary. It is at first unilateral, the process sometimes extending later to the opposite side through the prostate.

Symptoms.—Loss or increase of sexual desire and blood in the semen are occasional symptoms, but in most instances there are no direct manifestations of the vesicular disease, the symptoms being rather those of tuberculosis of the prostate or epididymis.

Diagnosis.—One-half the cases of vesicular tuberculosis occur in subjects less than forty years of age. The existence of the condition may be assumed when tuberculosis of the prostate or epididymis exists and the vesicles prove abnormal on palpation. The process starts as a nodular hardening near the outlet of the vesicle which may later extend to other portions of the organ, and is followed by caseation and softening. Upon palpation the vesicle may thus present a series of somewhat tender nodules; but frequently there is to be found merely a

dilated organ indistinguishable from that of simple chronic vesiculitis. After a time the process may invade adjoining structures, including the peritoneum. Exceptionally, the condition is spontaneously recovered from through walling off by fibrous tissue.

Treatment.—Vesicular massage and hot rectal douches do more harm than good in this condition, tuberculous epididymitis often suddenly following. The customary **general hygienic and dietetic treatment** of tuberculosis will, however, often yield good results, whether the vesicular tuberculosis be primary or secondary. If the disease progresses to diffuse softening or fistula formation, however, **vesiculectomy** is indicated. This is probably best performed through the same **perineal incision** as is used by Young in extraurethral prostatectomy (see Hypertrophy of the Prostate). The rectum having been so separated from the urethra and prostate as to afford access to the vesicles, the sheath of each vesicle is split, and the latter liberated as well as possible by blunt dissection, divided at the surface of the prostate, and removed with a portion of the vas deferens. If the entire organ cannot be freed owing to adhesion, the remainder is **cauterized or curetted**. The wound is then closed, **drainage** being afforded by a **cigarette drain**, for which a small tube may later be substituted.

TUMORS of the seminal vesicles are nearly always secondary to growths in the prostate, rectum, or bladder. **Excision**, where circumstances permit, is indicated.

DISEASES OF THE SPERMATIC CORD.

ANOMALIES of the vas deferens are occasionally met with, the canal being absent entirely or in part. (See also Hydrocele of the Cord, next page.)

WOUNDS of the spermatic cord cause atrophy of the corresponding testicle if complete section has occurred. Mere section of the vas results in obstruction to the passage of spermatozoa through it. Much hemorrhage may attend wounds of the cord owing to section of the spermatic artery or the pampiniform plexus.

Treatment.—The **vas**, if cut, should be **reunited with fine-silk sutures**. Not

infrequently restoration of the canal follows.

TORSION of the spermatic cord is an occasional acute complication of malposition of the testicles. (See **PENIS AND TESTICLES, DISEASES OF**, vol. vii.)

INFLAMMATION of the vas deferens may be associated with gonorrheal or tuberculous epididymitis. Tenderness along the cord is likely to be noted. An abscess of the intrapelvic part of the cord, upon rupturing, may induce peritonitis.

Treatment.—If an abscess is detected in that part of the cord which courses through the scrotum, an evacuating incision should be made.

HYDROCELE OF THE CORD

may be of the *encysted* or the *diffuse* (*multilocular*) variety. The former usually occurs where there has been partial failure of obliteration of the funicular process of peritoneum which passes into the tunica vaginalis surrounding the testicle. The funicular process being closed above and below, but open in its intermediate portion, a sac is formed in which serous fluid may accumulate. Occasionally 2 or more sacs in a row may be formed, the hydrocele being, therefore, multiple. The condition is usually encountered in children. The hydrocele is situated above the testicle, and cannot infrequently be worked upward and outward into the inguinal canal. Occasionally it is situated in the latter. Its physical features—translucency, etc.—are, in general, like those of the commoner hydrocele of the tunica vaginalis (see **PENIS AND TESTICLES, DISEASES OF**, vol. vii).

Less frequently, encysted hydrocele of the cord is actually a hydrocele into the sac remaining after reduction of a hernia, the neck of the sac having become obliterated.

Diffuse hydrocele of the cord is

usually an edema of the tissues of and surrounding the cord, or may be a multilocular cyst resulting from subdivision of an encysted hydrocele, echinococcus disease, or the presence of cysts of fetal remains such as the Wolffian body and Müller's duct. It is distinguished from encysted hydrocele by its indefinite outline and boggy consistency. It may, however, be fluctuating in places. A slight impulse on coughing may be observed.

Treatment.—If differentiation of the encysted hydrocele from hernia has not with certainty been made, the treatment should be **incision**. The margins of the sac having been sutured to the skin, its interior is swabbed with pure **phenol** and **drainage** instituted. Where the diagnosis is not in doubt, the **sac** may be **punctured** and its inner surface **scarified** with a **needle**. If this fails, especially in the case of a relatively large cyst, the hydrocele should be thoroughly emptied by **aspiration** and 5 to 15 minims (0.3 to 1 c.c.) of pure **phenol** at once injected into it and rubbed around in its interior. Another **aspiration**—without injection—may be required about ten days later if the tendency to refill has not been overcome by that time (Keyes).

Diffuse hydrocele of the cord may be **incised** or, frequently better, permitted to undergo spontaneous recovery.

SOLID TUMORS of the spermatic cord include especially lipoma of the cord, with which a fibromatous or myxomatous component may be mixed. Sarcoma, myoma, and fibroma of the vas deferens have also been met with. Generally the diagnosis from inguinal hernia is only made at operation.

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UROBILINURIA.—Urobilin is regarded as a normal constituent of the urine, being its principal coloring matter. In excess, it imparts a red-brown color. Urobilinuria occurs in fevers, in hepatic diseases, after hemorrhagic effusions; in purpura; and in progressive pernicious anemia and chlorosis. It is said to show that the liver is the cause of the disturbance. For its detection *spectroscopic examination* will reveal a marked absorption-band between Fraunhofer's lines *f* and *b*, fading off from the green into the blue.

Schlesinger's test has already been given (vi. 496); also Ehrlich's benzaldehyde test, and others (iii. 306; vi. 380). *Edelmann's test* makes use of two reagents, viz., a 10 per cent. alcoholic solution of mercuric chloride, and a 10 per cent. solution of zinc chloride in amylic alcohol. The reaction, when positive, is a red-green fluorescence. S.

URTICARIA.—DEFINITION.—

Urticaria is a mild inflammation of the skin, characterized by the sudden appearance of wheals, which are ephemeral and marked by stinging, pricking, or burning.

SYNONYMS.—Hives, nettle-rash.

SYMPTOMS.—An attack is usually preceded by lassitude, slight headache, epigastric oppression and various gastrointestinal symptoms, a coated tongue, a slight rise in body temperature.

The eruption appears abruptly, and may reach its maximum in a few minutes. It consists of wheals, in size from a split pea to a silver dollar or larger, firm and slightly elevated. Their number varies from four or five to one hundred or more. They are generally round or oval, but may have an irregular outline. They vary in color from white to pink, or bright red, but generally have a white, elevated spot in the center, with a more or less marked areola, are often isolated, but may coalesce. The lesions may appear in the mouth, pharynx, or upon the epiglottis, and give rise to symptoms of asphyxia; or on the tongue, when the organ suddenly swells.

The eruption is accompanied by burning or stinging. Scratching gives but temporary relief, and only increases the number and size of the wheals. The eruption may attack different portions of

the body in succession, remaining only a short time in each. Usually running an acute course—a few hours to one or two days—it may, however, become chronic unless the existing cause is removed.

Urticaria Papulosa (Lichen Urticatus).

—This occurs in young children that are poorly nourished or improperly fed. It occurs as a number of small, isolated papules, appearing suddenly, remaining for a day or two, and gradually disappearing; in size from a pin's head to a split pea, and developed around the hair-follicles. They are bright red in color, pale or white at the center, and generally appear upon the limbs. Itching is usually intense.

Urticaria Bullosa.—A rare form, characterized by bullæ as well as by large wheals. The wheals may be gradually converted into bullæ, the upper layers of the wheal being raised into a bleb by the subjacent serum, and becoming so large as to resemble those formed in pemphigus. Severe itching and burning are present.

Urticaria Nodosa (U. Tuberosa).—Very rare, and also known as giant urticaria. Large tubercles or nodules are suddenly developed in the skin and subcutaneous tissues, in size from a chestnut to a small egg, hard to the touch, elevated, and seldom appearing on the face. The itching and burning are intense, but generally disappear in a few hours. Incidentally we mention angioneurotic edema, also known as Quincke's disease, giant swelling, or acute circumscribed edema (see volume ii, page 201), which resembles this form, to call attention to the fact that it differs in that it chiefly attacks the face.

Urticaria Hemorrhagica.—Usually observed as a complication of purpura, and caused by a hemorrhage into the wheal.

Urticaria Intermittens.—In this variety the eruption appears regularly every two or three days, or on a certain day in each week. It remains a short time, disappears only to reappear again at the end of the same interval. Fever may be present.

Urticaria Perstans.—Known also as chronic urticaria, when the lesions tend to persist for days or weeks, or recur at regular or irregular intervals for months or years, until the source of irritation is discovered and removed. A fresh crop may appear daily.

Urticaria Pigmentosa.—Known also as *xanthelasmaidea*, in which buff-colored, wheal-like nodules, with or without itching, appear usually in the first six months of infancy, and are most abundant upon the neck and trunk. The nodules, or wheals, are split, pea-sized, with pinkish areolæ. The nodules later become yellow, and may remain stationary for years, some undergoing involution leaving brownish stains. Itching may be severe or absent. This variety resembles *xanthoma tuberosum*, except in the occurrence of ordinary wheals and its onset in early infancy.

DIAGNOSIS.—The sudden appearance of the characteristic wheals, their brief duration and disappearance without desquamation, and the itching and burning will make diagnosis easy. Various parasites and insects—bedbugs, fleas, mosquitoes, etc.—may produce wheals, but a central punctiform hemorrhage or blood-crust marks these cases.

ETIOLOGY.—Acute urticaria is usually produced through some alimentary disorder, the result of mechanical irritation of the stomach or bowel, or a toxemia. Intestinal parasites and undigested food act as mechanical irritants; substances capable of producing toxemia may be primarily toxic or may become so through putrefactive changes within the intestines. Idiosyncrasy to certain foods and drugs is an active cause. Among the foods most apt to cause urticaria are: crabs, lobsters, mussels, caviar, shrimps, salted fish, clams, oysters, cheese, buttermilk, sausage, scrap-ple, pork, veal, strawberries, raspberries, cucumbers, mushrooms, grape-skins, etc.

Urticaria may follow the use of various drugs: quinine, cubebs, copaiba, salicylic acid and salicylates, potassium iodide, morphine, turpentine, chloral, valerian, glycerin, arsenic, and many of the coal-tar preparations. Antitoxic sera—used in diphtheria, tetanus, streptococcus infection, tuberculosis, etc.—frequently induce an urticarial eruption. Irritation of the uterus or adnexa may precipitate an attack. Rupture or puncture of hydatid cysts, or of pleural effusions, may be causal agents.

Urticaria may occur in connection with malaria, rheumatism, Bright's disease, the eruptive fevers, pertussis, asthma, and

various nervous and gastrointestinal disorders. It is a frequent complication of scabies and pityriasis, and has been observed as a sequel of arsenical poisoning. Finally, direct local irritation—sting of nettle, bite of jelly-fish, mosquito, bee, wasp, etc.—may produce the disease.

PATHOLOGY.—Direct or reflex irritation of the cutaneous vasomotor nerves causes spasmodic contraction of the cutaneous vessels, followed by dilatation and exudation of serum. In consequence of this spasm a stasis of the local lymphatic circulation ensues. The superficial and deep vessels of the corium are involved. Migration of white corpuscles takes place. The cutaneous muscular fibers remain in a state of contraction and, by forcing the blood toward the periphery, produce the pale center and hyperemic areola of the wheal.

PROGNOSIS.—The prognosis is generally favorable. Suffocation may threaten when the lesions are located in the mouth and larynx. Acute cases can be promptly relieved and frequently subside spontaneously. Relapses, when they occur, are as easily relieved as the primary attacks.

Chronic urticaria may resist treatment for months, but it disappears on the removal of the causal irritation.

TREATMENT.—As nearly all cases arise from gastrointestinal irritation, **emetics** are indicated in *acute* cases if seen early. If seen later **saline purges**—**Rochelle or Epsom salt**—will be useful to rid the alimentary canal of any undigested or fermenting food. Intestinal antiseptics—**salol, phenacetin, acetanilid, sulphurous acid, sodium thiosulphate**—are beneficial in both *acute and subacute* cases.

In *chronic* cases the cause must be discovered and, if possible, removed. Careful attention must be paid to **diet, exercise, sleep, etc.** Arsenic by mouth, and **atoxyl (sodium arsenanilate)** by hypodermic injection on alternate days, yield good results. **Extract of belladonna**, $\frac{1}{10}$ to $\frac{1}{2}$ grain (0.01 to 0.02 Gm.) may be given in pill, three times daily.

In cases of *nervous origin* **climicifuga** acts well. The itching of urticaria may be relieved by local treatment—a **hot bath** containing a handful of **washing soda**, on re-

tiring, will be soothing; a warm bath may agree better, or a **hydrochloric acid tub-bath**— $\frac{1}{2}$ to 1 ounce (15 to 30 mil.) of acid to each gallon (4 liters) of water. Many drugs are recommended for internal administration: **calcium chloride**, 15 to 60 grains (1 to 4 Gm.) in milk, daily, or **calcium lactate**, one or two tablespoonfuls of a 5 per cent. solution before each meal; **dilute hydrochloric acid**, in medium doses to remove digestive errors; **extract of pilocarpus**, 15 to 30 minims (1 to 2 mil.) given three times daily, has given great relief.

Urticaria pigmentosa and *U. papulosa* in nursing infants have been successfully treated by giving the mother **mercury bichloride**, $\frac{1}{32}$ grain (0.002 Gm.), three times daily.

Pain and itching are met by a 1:1000 solution of **adrenalin**; **lime-water**; **potassium hydrate or carbonate** in 8:1000 solution (applied with a small piece of sponge); and **benzoin tincture** and **glycerin**, of each 1 part to 16 parts of **rose-water**. **Acetanilid**, plain or diluted with talc, may be used as a dusting powder, or **menthol** in 5 per cent. ointment. A favorite of J. V. Shoemaker was **phenol**, 5 to 10 drops; **sublimed sulphur**, $\frac{1}{2}$ dram (2 Gm.); **camphor**, 10 grains (0.6 Gm.); **zinc ointment**, 1 ounce (30 Gm.), applied frequently to irritable surfaces. **Phenol**, **tar**, **camphor**, and other antipruritics are useful. Finally **soft linen**, cotton, or silk **undergarments** are advised. W.

UTERUS, DISEASES OF.—MALFORMATIONS.—**Rudimentary Uterus.**—The rudimentary uterus may be of any size, from a cylinder-shaped body an inch long down to a slight thickening of tissue on the posterior surface of the bladder at the junction of the rudimentary Fallopian tubes. It is usually solid, but rarely a membranous sac. One or both ovaries may be present, usually also in a rudimentary state. The vagina may be developed, but is ordinarily represented by a shallow, blind pouch. The vulva is apt to be normal.

Absence of the Uterus.—This condition is rare, a slight rudiment nearly always being found *post mortem*, though impalpable during life.

EMBRYOLOGICAL MALFORMATIONS.—About the end of the eighth week of fetal life Müller's ducts begin to unite, the united lower portions forming the uterus and vagina, the upper ununited portions the Fallopian tubes. Because of faulty development during this union, which is complete at the end of the third month, malformations occur.

One-horned Uterus.—This indicates an arrested development of one of Müller's ducts. The organ is more or less fusiform in shape, and curves toward the corresponding Fallopian tube. The other side usually shows a rudimentary horn.

Two-horned Uterus.—This defect, due to imperfect union of the ducts, may involve the fundus only or cause a flattening (*uterus planifundus*) or slight depression of the fundus, or it may extend downward any distance toward the cervix (*uterus bicornis unicollis*), or into the cervix (*uterus bicornis bicollis*). Sometimes a septum divides the uterus (sometimes the vagina) below the junction.

Double Uterus.—Here union of the ducts has not taken place above the vagina. The two sides are entirely distinct, but the vagina may be single or double or septate.

Two-chambered Uterus.—Such a uterus is more or less normal in size and shape, but the septum persists, and may not extend as far down as the internal os (*uterus subseptus*), or it may divide the whole uterus and cervix, forming two cavities, or the septum may extend to the internal os only (*uterus septus unicollis*).

After complete union of Müller's ducts the following may result:—

Fetal Uterus.—The body is small, cylindrical, and may be solid. The cervix measures about one inch, and twice as long as the uterus. The papillary folds of the cervix extend throughout the cavity.

Infantile Uterus.—The uterus remains about the same as at birth. The body is but little over half the length of the cervix. The vaginal cervix is short, and the vagina and external genitals usually small.

Puerile Uterus.—Here the body is as long or a little longer than the cervix, and the external genitals small. The conditions previous to puberty persist.

Puerile Cervix.—The corpus is about normal in size, but the cervix is small and conical, with an extremely small external os. Ante-flexion and stenosis may be present.

SYMPTOMS AND DIAGNOSIS.

—The symptoms of one- and two-horned uterus, and of double and two-chambered uterus do not usually attract attention until puberty or marriage, when dysmenorrhea, amenorrhea, sterility, dyspareunia, or the signs and symptoms of atresia of the vagina, with retention, develop.

The shape and size of the uterus are determined best by the bimanual rectoabdominal examination. If the vagina and cervix be well developed, the cervix can be pulled down within better reach by a vulsellum, and the character of the interior of the uterus also determined with the sound.

If the diagnosis be difficult, it may be possible, with the aid of anesthesia, to introduce a finger into the bladder; then the uterus, tubes, and ovaries can be palpated between it

and a finger of the other hand in the rectum. When the uterus is rudimentary, slightly resisting cords, representing the Fallopian tubes, can be felt, joined on the posterior surface of the bladder and leading outward to the rudimentary ovaries, if such exist. If the uterus be one-horned, its fusiform shape can be palpated, extending laterally upward, and also the rudimentary horn on the opposite side. The two-horned uterus is easily recognized by the depression in the fundus, and the double uterus by the presence of two elongated hard bodies merging in the vagina below.

The fetal, infantile, and puerile uterus and cervix may be associated with atresia vaginæ or stenosis of the cervix (*q. v.*). The prognosis is unfavorable except for puerile cervix.

TREATMENT.—In the presence of one- or two-horned uterus, and of double and two-chambered uterus, there is little to do in developing or improving the organ; irremediable symptoms may call for removal of the ovaries or uterus, or both. Pregnancy in a rudimentary horn usually causes rupture and calls for removal.

Where either fetal or infantile uterus, or puerile uterus or cervix exists, some benefit may be derived from **intra-uterine bipolar faradization** and persistent periodical dilatation of the cervix if treatment is commenced soon after puberty. **Divulsion** by means of bladed dilators under anesthesia, with packing of the uterus for thirty-six hours, may be followed by **repeated packings**, provided the endometrium is douched out each time with an efficient antiseptic; afterward the cervix may be kept dilated by conical round dilators

twice weekly. **Pelvic massage** and movements adapted to develop the pelvic musculature and blood-supply are sometimes used.

STENOSIS OF THE CERVIX.

—This condition consists in a lack of development or atrophy of the part sufficient to interfere with uterine drainage. The contraction may be at the external or internal os, or exceptionally throughout the canal, and is often connected with flexion of the uterus. It may be due to puerility in the nullipara, to cicatricial contraction following cervical laceration in the parous woman, and to atrophy in the senile woman.

Symptoms.—Colicky dysmenorrhea, as in cases of antelexion, lasting from a few hours to a day or two, is the most common symptom. Colicky pains in the vesical region are sometimes felt between periods; discharge of mucus, blood, or pus may follow. In old people long retention of secretions, which usually become offensive and purulent (senile endometritis), may stretch the uterus until it resembles a bag. Endometritis is present in long-standing cases.

Sterility, which is often relieved by a dilatation of the cervix, is common.

Diagnosis.—When the stenosis is located at the external os, the orifice may be scarcely visible, or appear as a small dimple. If at the internal os, a small probe will demonstrate the partial or complete closure of the canal. If the cervix be small and flexed, the stenosis is probably related to imperfect development and displacement; if large and perhaps lacerated, it is due to induration and contraction of the mucous and sub-mucous tissues at or near the internal

os. In the latter case the internal os is apt to be quite sensitive to the sound, and may bleed a trifle upon its withdrawal. Thick cervical mucus will, as a rule, be visible.

Prognosis.—Patency of the cervical canal is usually obtainable, but is often hard to maintain in the virgin or old woman without occasional dilatation. The sterility can usually be relieved in quite young people; but, when hyperplasia or endometritis is established, sterility is apt to persist. In married women with stenosis and sterility, who do not apply for treatment for several years, the sterility is seldom relieved by dilatation.

Treatment.—In ordinary cases of partial stenosis presenting symptoms, and in young women with small cervix, **dilatation with graded sounds** twice weekly will cure stenosis of the *external* os in a short time. Stenosis of the internal os may require the dilatation twice weekly for three or four months, then once weekly for a year. The cervix is thus also caused to develop. The vaginal fornices and endometrium should be *disinfected* with a 5 per cent. **carbolic acid solution** through the speculum, and the uterus disinfected by tincture of **iodine**, **ichthyol**, etc. If it is done at the office, the patient should take a **douche of normal saline solution** before coming.

In old cases the cervix will probably require **forcible dilatation** by bladed dilators. The uterine cavity and cervix should be packed tightly for twenty-four hours after the operation, and the cervix kept dilated with a large sound or bougie (No. 18, American scale) two or three times monthly for several months.

Incision of the cervical canal is almost never required, except for cicatricial contraction or rigid ante flexion. In the latter case incision of the posterior wall of the cervix in the median line to the vaginal junction (**Sims's operation**) and a doubling in of the ends so as to obliterate the raw surfaces (**Dudley's operation**) may facilitate cure of stenosis of the internal os, but is seldom necessary.

LACERATION OF THE CERVIX.—This ordinarily results from abnormal conditions that interfere with the natural course of labor, such as large head, small or diseased cervix, malpresentation, premature rupture of membranes, precipitate labor, artificial dilatation of cervix, etc.

Unilateral and bilateral lacerations are most common, though posterior, anterior, multiple (stellate), diagonal, and annular ones occur. They may extend into the vaginal vault.

Symptoms and Diagnosis.—The symptoms are those of the inflammations and displacements. The fissures and flaps of the lacerated cervix can best be discovered by a digital examination, and by inspection with Sims's speculum. The bivalve speculum opens the fissures wide, and may deceive as to their size or existence.

Pathology.—Many moderate lacerations heal by adhesion, although the majority of deep ones cicatrize and contract with a cicatricial plug in the angle. Often mucous membrane seems to extend over raw surfaces, nothing but the fissure remaining.

Infection of the wounds is likely, with consequent cervicitis, parametritis, perimetritis, and perhaps pelvic abscess. The infection may also spread to the cervical, corporeal, and

tubal mucous membrane and the ovary and pelvic peritoneum. The cervical mucous membrane becomes hyperplastic, and pushes the lower ends of the cervical flaps outward, producing eversion (ectropion). All varieties of cervical inflammation, erosion, and degeneration are found related to and probably originating in lacerations.

Retroversion and lateral displacements of the cervix may result from the cicatricial contraction that attends those extending into the vaginal vault, and other displacements and fixations may follow peritonitis.

Treatment.—Extensive lacerations should be **sutured** immediately after labor if the conditions are favorable. The cervix should be carefully pulled down to the vulva by means of a vulsellum, shreds trimmed from the torn edges, and the wound-surfaces united in their original relation by hardened catgut sutures. If there is any doubt about the possibility of subsequent cleanliness, silkworm-gut sutures will give better results.

Old lacerations generally require applications of **carbolic acid**, or other disinfectant and astringent, to the eroded and hyperplastic mucosa, for the diseased surface can be much better treated before being turned into the cervix than after. Closure before curing the cervical endometritis often results in aggravation.

In **Emmet's operation**, a tenaculum is hooked into the lower, or distal, end of the cervix at one side of the fissure and the mucous or cicatricial surface of the latter cut off, commencing under the tenaculum and going up into the angle and beyond the cicatricial plug. The other side of the fissure may then be denuded

from the angle down, or from below upward as on the first side. If the laceration is bilateral, the fissure on the other side is similarly denuded, and then both wounds are sutured with hardened catgut or silkworm gut. It is well to place the first suture at the distal end of the flaps. Two per cent. **phenol douches** twice daily keep the catgut hard and clean.

When the lacerations are bilateral or multiple and extensive, and the cervical follicles extensively diseased, Schröder's operation should be performed to remove the diseased membrane and restore shape of the part.

Schröder's operation consists in lateral incisions through the cervix, or cicatricial plugs, on both sides, exposing all of the diseased cervical mucous membrane. The sides of the tears are denuded from these incisions down to the end of the cervix. Instead, now, of sewing up the parts, as in Emmet's method, the endocervical mucous membrane is dissected off between lines drawn across from the upper and lower ends of the raw lateral surfaces. The lower ends of the cervical flaps are then folded in until the mucosa reaches that of the cervical cavity above the denudation, and are sutured to it. Then the wounds left on either side are trimmed, if necessary, and sutured to close the lateral fissures. Before closing the cervix, apply tincture of iodine to the endometrium.

DISPLACEMENT OF THE UTERUS.

The uterus is normally located in the central and anterior portions of the pelvis. The cervix is suspended by the pelvic connective tissue (pubo-uterine, sacrouterine, and broad ligaments) just behind and often a trifle to the left of the axis of the pelvic cavity. Its range of mobility is small. The corpus leans over the bladder in slight anteflexion, the flexure varying with the fullness of the bladder and rectum. The former, when distended, lifts the fundus and straightens the uterus, while the latter, when loaded, pushes the cervix forward and increases the flexion.

The main factors in malposition are variations in the relative development of the pelvic organs and connective tissue, and injuries or other causes that diminish, destroy, or modify connective-tissue support. Pathological alterations in the uterus constitute a less important cause.

ETIOLOGY.—When the uterus is poorly or late developed, the connective tissue about the rectum and vagina offer relatively more support, and the uterus may be held up at the pelvic brim in a position called *elevation*. This is the position of the rudimentary and fetal uterus. Or, it may be held forward by the connective tissue at the base of the bladder in *anteposition*. This is often the position of the puerile uterus. An imperfectly developed vagina aids in maintaining this form of displacement. As the corpus uteri and pelvis grow, the connective tissue of the broad and sacrouterine ligaments may, as the result of constipation, debility, hard work, etc., be wanting in tone and fail to support the cervix firmly. Then, when the uterus is pushed backward by the distended bladder, the round ligaments, which nearly always share the flabby and immature nature of the corpus, do not draw the fundus forward, and abdominal pressure may turn the

temporarily retroposed organ back into *retroversion*, or, if the connective tissue about the cervix is firm enough, bend the corpus backward, producing *retroflexion*.

Normally strong sacrouterine connective tissues draw the upper part of the cervix backward, so that retroversion cannot occur, while a short, imperfectly developed fetal vagina may pull the vaginal portion forward causing a *congenital antelexion*. The corpus is small; the cervix may be elongated by the vaginal traction.

When the vagina is well developed, the anterior wall is $2\frac{1}{2}$ inches long; the bladder connective tissue does not draw the cervix too far forward. If the uterus develops late or remains small in an otherwise vigorous girl, the cervix is apt to be drawn by the vigorous sacrouterine folds backward and upward nearer the rectum and sacrum than normal, while the fundus is drawn by gravity, and pushed by abdominal pressure, downward in front of the cervix, becoming antelexed. Some atrophy and shortening of the anterior uterine wall is likely to take place, because the filling bladder does not lift the fundus sufficiently to straighten the corpus, nor is the dorsal position—normally bringing the fundus backward—able to do so. The flexion then becomes *permanent*, or *irreducible*.

Thus, many uterine displacements are errors in development due to inheritance of an imperfect *physique*, or to modes of living in early life that fail to insure symmetrical development. After puberty congestion and local inflammations modify or perpetuate these conditions. Thus, a hardening or rigidity of the uterus may render the flexion permanent.

As a result of the increased weight, and of relaxation in the sacrouterine tissues, the cervix may be carried by abdominal pressure toward the vaginal outlet—*anteponition*. If antelexion is permanent, we have both antelexion and anteponition; or if the sacrouterine ligaments are greatly relaxed, the body of the uterus is tipped backward by the bladder and abdominal pressure, and we have both *antelexion* and *retroversion*. If the uterine rigidity is due to puerperal metritis in an antelexed organ, the flexion may be prevented from returning and the corpus will tip forward without bending—*anteversion*.

General relaxation of the pelvic connective tissue due to pelvic disease, general debility, and increased intra-abdominal pressure from ascites or tumors allows the uterus to descend to the vaginal outlet, either with the uterine long axis in coincidence with the pelvic axis, constituting *prolapse*, or with the fundus in the *cul-de-sac* of Douglas, constituting prolapse and retroversion.

Injury, overstretching, laceration, and subsequent cicatricial contractions may, as they affect different parts, allow the cervix to sink toward the vaginal outlet, or draw the cervix from its normal location and cause the above-mentioned displacements in a previously normal uterus.

Inflammation and exudates may fix the uterus in its malposition, or may push or draw it to an abnormal location. *Lateral positions or versions* are usually caused in this way, and often the posterior deviations.

The same conditions that produce prolapse may cause *protrusion* of the uterus through the vulva. When the conditions are those of relaxation the

cervix protrudes first, and inverts the vagina. This is the mechanism in the virgin and nullipara. When protrusion results from lacerations about the vaginal outlet, the vagina appears first at the vulva, dragging the uterus after it. The bladder protrudes with the uterus, and at times the rectum.

When the uterus is fixed in the pelvis by adhesions the traction of the vagina upon the cervix is apt to produce elongation, and some hyperplasia, of the cervix, and only moderate descent of the fundus, causing *prolapse*, or *protrusion*, of the cervix.

ANTEFLEXION AND ANTEVERSION.—Symptoms.—The most common symptom of permanent or irreducible ante flexion is dysmenorrhea, due to interference with the drainage and circulation of the uterus. The pain may commence with the first menstrual period or not until some years later. It is a cramping pain in the lower abdomen felt about the time the menstrual discharge appears, and if there be no complication ceases when the flow is well established. Since utero-ovarian congestion and hyperplasia gradually supervene, the pain, after a time, lasts longer and is more continuous. Soreness in the lower abdomen, iliac and lumbosacral regions may then persist throughout. Between the periods the symptoms are those of ovarian and uterine hyperemia.

In retroversion, backache and the other symptoms of the causative inflammatory conditions are present.

Diagnosis.—The diagnosis is made by the bimanual examination. When the uterus is in the front part of the pelvis, the fundus, often small, is felt over the anterior vaginal wall and the cervix toward the perineum.

When the uterus is retroposed, as is usually the case when the parts are well developed, the cervicovaginal junction is found well back in the pelvis, making an acute angle anteriorly. With the tip of the index finger touching the junction of the cervix with the anterior vaginal wall, the subpubic arch should normally be against the finger at or beyond the middle of the third phalanx (over two and one-half inches). The posterior fornix is unusually deep, and the posterior surface of the cervix may be felt to be convex in its long diameter. The angle of the anterior uterine wall formed just above the vaginal junction can usually be felt and sometimes the fundus itself. If antiseptic preparations have been made, a sound may be passed to locate the uterus and differentiate from a tumor or exudate that might be mistaken for it.

In anteversion the anterior vaginal wall is about three inches long as measured on the finger, but the os uteri is still farther back, and points toward the coccyx or sacrum. The cervix extends backward, and the corpus forward over the anterior vaginal wall, and is in a straight line with the cervix. The organ is usually larger and harder than is usually the case.

Treatment.—The treatment of ante flexion sufficient to cause symptoms should be a **systematic dilatation** of the cervix with **graded conical sounds**, or a **rapid dilatation**. After the latter, dilatation should be maintained by means of the occasional passage of a large sound under the strictest antiseptic precautions. The endometritis may require treatment, or measures may be indicated such as are recommended elsewhere for puerile uterus.

RETROFLEXION AND RETROVERSION. — Symptoms. —

These, like other uterine displacements, cause no symptoms unless connected with inflammation or interfering with the menstrual flow or the uterine circulation. If dysmenorrhea is present, it often commences with cramping pains in the lower abdomen, as in antelexion, but the pains do not usually cease as soon as the flow begins, and may continue throughout. Backache is common, and is apt to increase during the period. Bladder traction may cause persistent vesical irritability. Symptoms of pelvic inflammation are often present.

Diagnosis.—In retroversion the cervix is within two inches of the vaginal entrance and points toward the pubes, while the body can be felt to extend nearly straight backward into the hollow of the sacrum. In retroflexion the angle formed by the posterior walls of the cervix and corpus can be felt, and the body of the uterus is in or over the *cul-de-sac* of Douglas. To avoid mistaking it for a tumor or exudate, the absence of the former from its normal position can be readily demonstrated bimanually. If necessary, a sound may be introduced.

Treatment.—If adhesions are present with exudate or diseased ovaries, these should be treated. Interference of the flexion with drainage may necessitate forcible dilation.

If, after the pathological conditions have been as far as possible corrected, the patient still suffers, the uterus should be replaced and kept in position by a pessary or by an operation. **Replacement of the uterus:** With two fingers in the vagina push the

cervix and posterior vaginal wall backward, and press the external hand down into the pelvis just below the promontory of the sacrum, and push the fundus, which is raised by the backward pressure against the cervix, forward to the pubes. If this cannot be done, two fingers in the rectum may be made to push the fundus up out of the hollow of the sacrum so that the hand on the abdomen may pull it forward over the pubes. In the genupectoral position the weight of the uterus and abdominal organs may be made to assist. Küstner draws the cervix down toward the vulva with a vulsellum until the fundus is drawn out of the *cul-de-sac* of Douglas, and then turns the handle of the instrument up toward the pubes externally and pushes the cervix back toward the sacrum where the fundus had lain.

The replaced uterus may be held a few months by a pessary. The retroversion will usually recur when it is removed, but the symptoms may not.

The Albert Smith or Emmet are the best forms. They are introduced with the short curve turning upward behind the uterus.

When pessaries fail to relieve the symptoms, operations are indicated. If the uterus can be perfectly replaced and the fundus remains temporarily near the anterior vaginal wall after being released, and the parametrium feels soft, **Alexander's operation of shortening the round ligaments** through the inguinal canal may be relied on. If there are adhesions to be separated or ovaries to be resected, or if the uterus immediately retroverts after being replaced, a vaginal or abdominal incision should

be made, pathological states of the ovaries and tubes (*q. v.*) be attended to, and the round ligaments be shortened through the incision. The latter and slight peritoneal adhesions of the fundus to the peritoneum over the bladder with catgut sutures constitute all that is ordinarily required.

PROLAPSE AND PROCIDENTIA.—**Symptoms.**—Backache, dragging sensations about the pelvic outlet, and difficulty in urinating and defecating are common symptoms. In procidentia, ulceration of the protruding vagina or cervix, cystitis, and urethritis may be troublesome. Leucorrhea and other symptoms of pelvic hyperemia, neurasthenia, debility, indigestion, etc., often complicate.

Diagnosis.—In prolapse the cervix will be found near or at the vaginal entrance, with or without a protrusion of the anterior or posterior vaginal wall or both (anterior and posterior colpocoele), carrying, perhaps, the bladder (cystocoele) or rectum (rectocoele) with it. A recto-abdominal, bimanual examination reveals the fundus either in the *cul-de-sac* or low down behind the pubes.

In protrusion the cervix uteri can be seen, and will admit the uterine sound. Rectal palpation reveals the absence of the uterus from the pelvis, and perhaps the projection of the anterior rectal wall into the vulvar tumor. A catheter introduced through the urethra will show whether the bladder is up behind the pubes or external to the vulva. In complete procidentia its posterior wall usually follows the cervix out of the pelvis.

The parts can be pushed back into the pelvis and be palpated in their normal relationship.

In case the cervix only is prolapsed

and elongated the uterine sound will usually penetrate four or more inches. The rectal examinations inform us that the fundus is only moderately prolapsed, while the cervix is long and thin. When the elongation is just above the level of the anterior vaginal junction, the anterior vaginal wall comes down with the cervix and the posterior vaginal fornix retains more or less of its depth. When the elongation is in the upper part of the cervix above the posterior vaginal junction, the posterior fornix descends. When both of the fornices remain deep it is mainly the vaginal portion of the cervix that is elongated. Supravaginal elongation is usually merely a stretching of the cervix.

Treatment.—Operative treatment is, as a rule, necessary for the cure of protrusion. However, in many cases without distressing symptoms the patient may prefer palliation.

The patient can ordinarily push the parts back and retain them during the daytime by introducing large cotton or wool **tampons**, or a rubber **inflatable bag**. A soft-rubber elastic **ring-pessary** or a **hard-rubber globe pessary** can sometimes be introduced every morning and removed every night. Soft-rubber pessaries should never be worn continuously. A hard-rubber or large **Albert Smith pessary** can be worn continuously with great comfort in some cases. The prolapse returns when the pessary is removed.

When the prolapse is the result of lacerations during childbirth it is usually necessary to repair the laceration or amputate the enlarged cervix, perform anterior and posterior **colpotomy** and **perineorrhaphy**, as well as remove any **hemorrhoids** or protruding

anal folds. If the fundus uteri sinks into the hollow of the sacrum as the cervix is pushed within the pelvis, it is best to perform **Alexander's operation.** In case the patient is at the change of life, **vaginal fixation**, or uniting the anterior wall of the uterus to the anterior vaginal wall, may accomplish the same purpose.

In extreme cases the uterus has been removed by **abdominal hysterectomy** and the stumps attached to the abdominal incision. **Vaginal hysterectomy**, supplemented by a **narrowing of the vagina** and **perineorrhaphy**, has also proved successful.

INVERSION OF THE UTERUS.

—Inversion signifies a turning of the corpus uteri into the cervix (partial) or through it (complete). The uterus turns inside out. It only occurs when the uterus is (1) enlarged and (2) partly or completely relaxed. These conditions are found in the puerperal state and in polypoid or submucous uterine tumors (usually myomas).

The causes in the puerperal state are pressure upon the fundus uteri or traction upon the umbilical cord, or both, during the third stage of labor. Adherent placenta and a short cord favor it. After a partial inversion has taken place, abdominal pressure may complete it, or the projecting fundus or tumor may be caught in the cervix and be expelled into the vagina by the contractions above it.

Symptoms and Diagnosis.—Sudden complete inversion occurring during labor is often accompanied by fatal hemorrhage unless immediate reduction is effected. If the patient escapes death, septicemia is apt to follow.

More often the onset is gradual and hemorrhage is more or less continuous and abundant. **Leucorrhœa**

and metrorrhagia, with the symptoms of metritis, anemia, and nervous exhaustion, are the chief symptoms.

An inverted uterus may be differentiated from a fibroid polyp as follows:—

The inverted uterus in recent cases is darker, softer, and more sensitive, and the cervix is represented by a shallow depression all the way around. A fibroid can be twisted slightly without carrying the cervical rim with it. The cervical rim can sometimes be made to disappear by traction on the fundus, inverting the entire organ. The Fallopian orifices can sometimes be detected and the relations thus determined.

Bimanual rectoabdominal examination demonstrates the absence of the fundus from the pelvis, a cup-shaped depression, and in old cases the ovaries at the edges of the depression.

When the uterus is completely inverted by a polypus, the deviation of the polypus from the size, symmetry, and evenness of surface of the uterine body, and a depression at the level of the attachment may aid diagnosis. A shallow incision, which can be quickly sutured, will reveal the tumor structure and existence of a capsule.

The fundus may be (1) merely indented, or (2) the entire corpus may project through the cervix, or (3) the cervix and corpus may be inverted. The first and third conditions exist, as a rule, only temporarily and during traction upon the corpus; hence the second one constitutes the type.

Before involution, the peritoneal cup in the cervix is large, containing the tubes and ovaries. Right after labor the fundus projects into the vagina as a large, soft, purplish,

spongy mass. This gradually becomes smaller, harder and smoother. The discharge, at first bloody, soon becomes a bloody mucus, and the membrane assumes the characteristics of hyperplasia.

After involution the body becomes hard and pear-shaped, and the ovaries and tubes are no longer contained in the peritoneal cup. The mucous membranes atrophy, although in places glandular pockets form. Gangrene of the fundus is very rare.

Prognosis.—Hemorrhage, local discomfort, leucorrhea, etc., may lead to anemia and exhaustion. In the puerperal state immediate death from hemorrhage or inflammation, or perhaps later from sepsis, may occur.

Treatment.—At once after labor, the knuckles should be pushed steadily against the projecting mass until it recedes through the relaxed cervix. Then use **ergot** hypodermically, judicious **massage** over the fundus, or—if necessary—a hot **intra-uterine douche** or **antiseptic gauze packing**.

In recent cases beyond the puerperium **taxis** may suffice. Prolonged traction upon the cervix with a **vulsellum** combined with attempts to enlarge the cervical ring by eccentric pressure, and compression of the corpus uteri with the hands or padded forceps, may be followed by an attempt to indent one of the horns by the fingers formed into a cone, while the traction is being kept up.

Counter-pressure with the index fingers in the bladder and rectum, while the thumbs in the vagina press against the fundus, may succeed.

In older cases the **gradual method** is the best. The fundus is pushed back toward the sacrum, and a rub-

ber bag is introduced between it and the coccyx and sacrum, and inflated. By pressure toward the pelvic brim resistance of the uterine tissue is thus gradually overcome. The vagina is thoroughly douched before each introduction of the bag, which is cleaned every forty-eight hours. Two or three days, or as many weeks, may be required for the reduction.

When all other methods fail, an **operation** will usually succeed. The posterior uterine wall may be incised longitudinally in the median line, and the cervix stretched by means of dilators introduced into the peritoneal cup through the incision. If the constriction ring dilates sufficiently, the incision is sutured and the fundus pushed up through the dilated parts (B. Bernard Brown).

In case the cervix does not yield to the dilators, the incision can be lengthened until it extends from the fundus through the cervix into the posterior vaginal wall. At its extremity a transverse incision is made across the posterior vaginal fornix into the *cul-de-sac* of Douglas, and the uterus is easily turned right side out and sutured in the vagina. Then the fundus is pushed through the posterior vaginal opening and up into its proper position (Küstner).

Because of the liability to retroversion and adhesions after posterior incision, it is best to incise similarly the anterior uterine and vaginal walls, separate the bladder, open the peritoneal cavity, restore the uterus to its normal shape, suture the uterine incision, and attach the fundus over the bladder, and—if necessary—shorten the round ligaments intraperitoneally, before closing the vaginal incision.



Tuberculosis of Uterus and Alhexa.

T. G. Thomas recommended **celiotomy and dilating the cervix** from the peritoneal side. When this fails Everke incises the posterior cervical wall, and—if necessary—the anterior, reduces the displacement, and then sutures the uterine wound.

TUBERCULOSIS OF UTERUS AND ADNEXA.

TUBERCULOSIS OF THE BODY OF UTERUS may be caused, primarily, by tuberculous semen, instrumental inoculation, etc., but is nearly always secondary to tuberculosis in other parts. Although in the corpus it may exist in any stage, the miliary form is not recognizable clinically, and hence the ulcerative stage is the one usually encountered. The disease commences as small miliary tubercles, usually near the fundus, and spreads diffusely throughout the mucous membrane. In a few instances it develops in the uterine wall, constituting the interstitial form. The **Fallopian tubes** are about as frequently affected as the uterus itself; the **ovaries** are next in order.

Symptoms and Diagnosis.—The early symptoms are those of endometritis, sometimes with menorrhagia. Later the uterine walls are thickened, and there is a grumous discharge containing cheesy particles. The **menses** are then apt to be scanty.

The diagnosis may be based on uterine scrapings or inoculation of a guinea-pig. Tubercles in other organs, absence of foul-smelling, watery discharges, and slow progress distinguish it from cancer or sarcoma of the endometrium.

Treatment.—Removal of the uterus and appendages should be practised *per vaginam* unless the condition is

secondary to advanced tuberculosis elsewhere. If the appendages are palpably affected, or if there be encysted tubercular peritonitis, the abdominal method is preferable.

If hysterectomy is contraindicated, curettage and packing with iodoform might retard the disease.

TUBERCULOSIS OF THE CERVIX.—This consists of a round-cell infiltration of the subepithelial structures, containing tubercular nodules. The glands show proliferation and sometimes form papillary masses. The vaginal portion is somewhat enlarged, nodular, and partly covered by a circular granular wound that gives off a sticky, grumous discharge.

Symptoms.—These are at first those of cervical endometritis. Later the grumous discharge, containing glandular matter, the local pain, and the microscopic evidences from excised tissue serve for a diagnosis.

Prognosis.—The prognosis is usually bad because of disease elsewhere. If discovered early, the area of localization can be extirpated.

Treatment.—In the early stages a high amputation of the cervix may be depended upon unless uterine scrapings show signs of tuberculosis or decided inflammatory changes in the endometrium. If the vaginal fornices are affected, excision of the vaginal wall should be done well beyond the disease and the wound strewn with iodoform and sutured.

TUMORS OF THE UTERUS.

MYOMA OF THE UTERUS.—Uterine myoma consists of one or more masses of fibromyomatous tissue. According to their location there are several varieties.

The **polypoid tumor** develops near

or just under the mucous membrane, and, as it grows larger, projects into the uterine cavity. It remains attached by the mucous membrane and a few connective-tissue fibers, which form a pedicle of greater or less size and density, according to the amount of fibrous tissue. The *submucous* starts a short distance from the mucous membrane and projects more or less upon the surface. The uterine cavity in these two varieties enlarges as the tumor grows. The *intramural* develops well within the uterine wall and retains a thick covering of uterine fibers. The uterine cavity enlarges in proportion to the relation of the tumor to the mucosa. The *subperitoneal* variety is developed near the peritoneal covering, and causes a projection upon the serous surface without increasing to a great extent the size of the uterine cavity. The *pediculated* tumor develops just under the peritoneum and projects from the surface. The *intraligamentous* tumor projects into the connective tissue of the broad or sacrouterine ligaments. From 5 to 10 per cent. develop in the cervix. Myomas may be single or multiple, each with a capsule, or several masses may be developed in one capsule.

Symptoms.—In the polypoid, submucous, and interstitial varieties menorrhagia and metrorrhagia occur, with or without mucous or watery discharges between. The menopause may be delayed beyond the fiftieth year. Such tumors may cause painful uterine contractions either by pressure on the cervix (acting like a foreign body in the uterus) or from obstruction of the cervix by the projection of a tumor growing near the cervix. The interstitial and sub-

mucous varieties may cause ovarian hyperplasia, with its symptoms; or painful pressure upon the rectum, bladder, or pelvic nerves; or even obstruction of one or both ureters.

Sterility, early abortion, and dystocia are apt to be present. Anemia is a common result of the loss of blood.

The subperitoneal and intraligamentous growths have but few symptoms until large enough to press upon the surrounding organs, when they cause pelvic pain, vesical and rectal distress, constipation, and, rarely, serious impaction of feces in the colon.

Diagnosis.—*Single intramural, submucous, and polypoid* myomata enlarge the uterus symmetrically, and must be differentiated from pregnancy, hematometra, flexions, carcinoma, sarcoma, and subinvolution. The introduction of the sound when pregnancy is excluded, and, in case of large tumors, the introduction of the finger, reveals the increased size of the cavity and perhaps the presence of a polypoid or sessile growth. In case of flexion the sound passes directly into the supposed tumor instead of over or behind it. The symptoms of the above-mentioned conditions should be looked for.

Intramural multiple myomas produce a characteristic irregular enlargement and hardening of the uterus, with long, irregular cavity that is difficult to sound. Adherent ovarian tumor or inflamed appendages present a distinct history of inflammation, with a congested or hyperplastic cervix, tenderness, and a sulcus between the uterus and the projecting mass. The uterine cavity may be but slightly enlarged. A myoma of the vaginal portion gives the

os a crescentic shape, with flattening of the opposite lip. Carcinoma does not thus alter the shape of the os, is harder, and, if ulcerated, is excavated and fissured. The tenaculum holds in fibroid, but tears out of cancer easily and causes free bleeding.

Very large soft myomas or cystomyomas of the corpus cannot always be satisfactorily diagnosed. The myoma usually draws up and immobilizes the cervix, and the uterine cavity admits the sound farther than normal. The uterine body can be palpated, and the vascular murmurs can be heard. Slow growth is typical of uterine myomas and ovarian dermoids.

Etiology.—They are supposed to develop from the walls of the blood-vessels. Vascularity in connection with microparasitic development would seem to be in line with the recent discoveries in bacteriology.

Pathology.—The young tumor is composed of fibrous and muscular tissue irregularly interlaced in various proportions. It presents a whitish or yellowish-white, glistening surface, unless much muscle exists, when it is pinkish. The submucous and polypoid tumors retain some of the glandular structure of the mucosa, while a variety called adenomyoma is partly composed of glandular structure, and when cut presents the appearance of a coarse network, instead of the ordinary smooth sheen.

As they develop they usually deviate somewhat from the type. Those which are surrounded by anemic tissue, as the multiple and subserous, grow slowly and become hard and fibrous, and sometimes calcareous. Those which are surrounded by

vascular tissue, as in the single intramural and submucous, grow comparatively fast, but, having a poor blood-supply within, tend to undergo edematous, myxomatous, cystic, fatty, and even sarcomatous and carcinomatous changes. The hard tumors seldom grow very large, the soft ones often do, while the cystic may even destroy life by their great size.

Prognosis.—Growing slowly and tending to stop growing after the menopause, they may prove comparatively benign, yet in young people the persistence of the hemorrhages and gradual growth may seriously impair health before the delayed menopause.

Treatment.—The best treatment for growing myomas in women under 35 years of age is removal (**enucleation**) of the tumor, with preservation of the uterus, if possible, otherwise by hysterectomy with preservation of the cervix and ovaries. Removal of the ovaries for fibroids has now given way to **myomectomy** or **myotomy**. In older patients persistent hemorrhage, pressure pains, or rapid growth may call for radical treatment unless palliative measures are rapidly beneficial. Slowly growing tumors near the menopause without symptoms require only palliative treatment, and often no treatment at all.

Polypoid or sessile intra-uterine growths smaller than a child's head at term can be removed through the dilated cervix, by **morcellation**. The uterus usually contracts readily after this; if not, a tight packing with gauze, to be removed during the second twenty-four hours, and **ergot** internally, will prevent hemorrhage.

Small subserous or intramural growths palpable on the anterior or posterior uterine walls can be enucleated and the bed sutured through an incision in the anterior or posterior vaginal fornix (anterior or posterior **colpotomy**). Such tumors, when larger than an egg, require abdominal section for their enucleation. Polypoid and submucous tumors larger than a fetal head at term can be enucleated by abdominal section. The uterus can then be sutured with catgut, and, if the bed cannot be obliterated by sutures, it can be packed with gauze that extends out through the vagina, and the peritoneal side be closed. **When many intramural myomas** are present the uterus may be amputated at the internal os (**supravaginal hysterectomy**) or be removed with the cervix (total extirpation, **panhysterectomy**). Multiple small fibroids with symptoms may be treated by vaginal hysterectomy.

Enucleation.—This is accomplished by making an incision across the tumor, catching hold of it with a vulsellum or hook, enucleating with the fingers or blunt-edged instrument, and sewing up the bed with formaldehyde or formalin catgut.

Abdominal supravaginal hysterectomy is performed about as follows: Trendelenburg's position. Incision in median line extending from above pubes to below umbilicus. Separation of adhesions. Incision of capsule of any tumor that may be held down in pelvis, and enucleation of the tumor from its broad-ligament bed. Separation of the bladder from the uterus. Ligation of the ovarian and uterine arteries, or of the broad ligaments down to the internal os, clamping next to the uterus. Section

of broad ligaments between ligatures. Amputation of cervix at the internal os. Disinfection of cervix. Excision of a transverse, wedge-shaped piece from cervix, leaving an anterior and posterior flap. Paring out the cervical mucous membrane. Suture of the two cervical flaps with superficial catgut sutures. Suture of anterior peritoneal flap over the stumps of broad ligaments and uterus.

Abdominal total hysterectomy is similarly performed until the uterus is amputated at the cervix. Then the entire anterior cervical wall may be divided in the median line, or the anterior vaginal wall may be grasped just in front of the cervix by forceps and the vaginal canal opened between the forceps and the cervix. An incision is then carried laterally around the cervix guided by the finger passed through the opening made. When the cervix is cut out catgut sutures and ligatures are put on the vaginal edges, and, if possible, all raw tissues drawn together. If this is impossible, the unapproximated surfaces should be packed with gauze that extends into the vagina, and the peritoneum be united over it.

Vaginal hysterectomy for fibroids is usually performed for tumors from the size of an egg to a fetal head at term. A curved incision is made in the vaginal wall around the anterior edge of the cervix, and extending from the sides of the cervix straight out laterally for half an inch on either side. The bladder is pushed away from the uterus, and the peritoneal cavity opened, if possible, by tearing. A corresponding posterior vaginal incision is made, and the peritoneal cavity opened just behind the cervix. The bases of both broad ligaments

are ligatured with strong catgut, and the uterus cut loose from the broad ligaments on either side as high as the ligatures are placed. The cervical canal is then incised laterally and the anterior wall of the cervix amputated. The anterior uterine wall is then grasped with tenaculum forceps, and a triangle is cut from its center. Another is cut from either side extending higher up, and as tumors are encountered they are cut up and enucleated. Pretty soon the anterior uterine wall and tumors are all removed, and the posterior wall folds upon itself, allowing the fundus and uterine appendages to be pulled down into the vagina. The remainder of the broad ligaments are now ligated, and all uterine tissue cut away. The peritoneum is brought down with forceps and stitched to the vaginal walls before and behind, and then the anterior and posterior vaginal walls are brought together with sutures that catch and hold the stumps.

Palliative treatment is used for hemorrhage or pain and to check tumor growth. **Ergot** is one of the valuable palliative remedies. Occasionally it expels polypoid and sessile tumors through the cervix. Bleeding may be reduced and sometimes tumor growth arrested. Half a dram (2 Gm.) may be given three times daily for half or two-thirds of the time, and be continued, if necessary, for a year or more, or off and on until the change of life. Fluidextract of *hydrastis Canadensis* ($\frac{1}{2}$ dram—2 Gm.—three times daily) has been credited with properties of a similar character.

The **X-ray** applied through the vagina or skin may check hemorrhage and retard the growth somewhat.

Radium introduced into the uterine cavity has the same effect.

Curettage also acts beneficially upon the endometritis, and thus upon the hemorrhage.

Ligature of the vessels supplying the uterus acts temporarily only.

Among 32 cases of fibroids subjected to massive **X-ray** exposures on account of severe menorrhagia, permanent amenorrhea resulted in 78 per cent. and temporary amenorrhea in 22 per cent. Below 45 the X-ray should be employed only when operation is inadvisable or refused. Between 45 and 55, it is the method of choice. Hemorrhages due to fibroids after 55 should raise a suspicion of sarcomatous degeneration. Brettauer (Amer. Jour. of Obstet., Sept., 1918).

CARCINOMA OF THE UTERUS.

CERVIX UTERI.—Carcinoma affects the cervix uteri more often than any other organ. It occurs at any age after puberty, oftenest between the thirty-fifth and sixtieth years.

Three varieties are met with, viz.: the pavement-cell carcinoma and the ulcerating and infiltrating (nodular) forms of the cylindrical-cell carcinoma. The pavement-cell variety starts, as a rule, on the vaginal portion, and the cylindrical-cell within the cervical cavity; but when, from laceration, erosion, or other cause, the endocervical epithelium becomes squamous, or that of the vaginal portion cylindrical, the place of origin may correspondingly change.

Squamous-cell carcinoma commences as a papillary growth covered by thickened layers of epithelium. The changes are largely confined to the surface till they reach the vaginal wall, by which time they invade the deeper structures. It does not extend to the cylindrical epithelium of the

cervix until late. The overproduction of epithelial cells is surrounded by an overgrowth of connective tissue, producing fingers that seem to project in the deeper tissues. The surface soon becomes fissured and necrotic, and is covered by a grumous, sticky, offensive discharge containing cell debris.

Cylindrical-cell carcinoma starts as a small nodule in the mucous membrane that may spread superficially, producing extensive ulceration. It extends quite early into the uterus, but is late in crossing to the pavement epithelium of the vaginal portion.

In other cases the cervical walls are infiltrated before ulceration is extensive, and the cervix is enlarged and hardened, and exhibits the histology of carcinoma. Later the process of necrosis excavates the cervix until nothing but a shell is left.

In all forms ulceration follows sooner or later; the extension and excavation may in time reach the bladder, rectum, or ureters, and finally open these organs, and may convert the pelvic interior into a large ulcerating cavity. Obstruction of the ureters may be caused by infiltration.

Symptoms and Diagnosis.—Occasional slight hemorrhages, becoming more frequent and later more abundant and offensive, constitute one of the first symptoms. A gray, watery discharge, resembling dish-water and increasingly foul, occurs between times. Pain is usually a late symptom, and is a result of extension to the surrounding tissues. A severe pain extending into the iliac region or hip is more often the earliest pain. Later, pains due to cystitis, rectitis, or peritonitis may become prominent.

Anemia, general debility, faulty digestion, septicemia, and uremia occur from local inflammation and sepsis.

Squamous-cell carcinomas give to the examining finger the notion of an induration or tumor of the cervix; in early cases a mere projection of one lip, later a large mushroom-shaped growth. The surface, at first smooth and hard, soon becomes fissured and friable, and bleeds freely on firm pressure. The os is seldom in the center, as in laceration and eversion, for the changes commence on one part of the circumference, and affect that part first and most.

The surface, before ulceration, has a purplish color, with grayish patches of epithelial cells. The ulcerated surface is irregularly fissured, has a vascular border, and is mottled, due to yellowish-gray necrotic areas surrounded by vascular spots. A cheesy substance can be pressed out. All manipulations produce a persistent, bloody oozing. If the odor is not perceptible upon introducing the speculum, it will appear when discharge is seen or the finger smelled.

Cylindrical-cell carcinoma without infiltration does not alter the cervix till advanced, unless eversion exists. The sound or dilator usually brings out a thin, foul discharge, or granular matter and blood. If there is eversion an irregular-fissured, excavated, yellowish-red ulcer, with abrupt vascular edges, will be seen.

The infiltrated cervix feels hard and globularly enlarged, the largest portion being above the vaginal junction. The vaginal portion may be normal in color, but a tenaculum hooked into it will tear out easily and cause free bleeding—not in a

hyperplastic cervix or one enlarged by myoma. Just before ulceration the cervix may present a yellowish-pink, granulated, glistening surface that in connection with the above is quite characteristic. The tenaculum easily tears out of a cystic cervix, but the laceration tissue does not bleed profusely, as in carcinoma.

If the surrounding parts are infiltrated, glands will be felt beside or behind the cervix, or indurated tissue extending from the cervix under the broad or sacrouterine ligaments, often reaching to the walls of the pelvis and immobilizing the uterus. When the ulceration reaches the vaginal junction, the parametrium is infected.

PROGNOSIS.—The only hope of a cure is to remove the cervix or uterus very soon after the commencement of the disease. With the vaginal walls or parametric glands involved, cure is not to be expected.

TREATMENT.—The best treatment is **abdominal hysterectomy** with removal of as much tissue about the cervix as possible. Emil Ries, in this country, and Wertheim, in Europe, developed the modern operation. In cases discovered previous to ulceration or infiltration of the cervix, a **vaginal hysterectomy** followed by **X-ray** treatment or **radium** applications to the vaginal vault, as soon as healed, may be expected to cure. But early diagnosis is rare.

Vaginal hysterectomy is performed somewhat differently for carcinoma than for myoma or inflammation, as one must remove as much of the surrounding tissue as possible. The diseased tissue is curetted away and the cervix and uterine cavity mildly cauterized. An incision is made around the cervix in the vaginal wall fully

half an inch from the diseased area. After separating the bladder, pushing it high up, and opening into the peritoneal cavity both before and behind, heavy-silk ligatures are placed upon the bases of the broad ligaments about half an inch from the cervix, and tied as tightly as possible, in order that the tissue may afterward slough off. The bases of the ligaments are then cut through, and the upper portions tied. The uterus is then cut loose, the peritoneum joined with catgut to the anterior and posterior vaginal walls, the stumps united in the median line, and the corners or sides of the vaginal wound closed at the sides. The ligatures are left long, and hang out from the wound. Sterilized iodoform gauze is packed into the wound and against the stumps and in the vagina, and left for four or five days, when it is removed and an unirritating antiseptic douche used. The patient is kept in bed two weeks, given only water the first twenty-four hours, liquid diet during the second and third days, and very simple, mostly liquid, diet for the remainder of the first week. The ligatures, if tightly tied, will come off in two weeks.

Vaginal hysterectomy with forceps differs in that long-handled hemostats are applied to the broad ligaments instead of ligatures, and are left for thirty-six or forty-eight hours. A pair is placed at the base of each broad ligament, including the sacrouterine ligament, and after the cervix is cut loose another pair is put on the remainder of each ligament. The connective-tissue vessels are secured by lighter forceps. A gauze packing is then placed between the forceps and left for two days after

the forceps are taken off. The patient suffers greatly until they are removed.

When a radical operation is inadmissible, the diseased area may be thoroughly curetted and cauterized with the strong solution of **chloride of iron** or a 50 per cent. solution of **zinc chloride**, applied on a pledget of cotton held against the wound for twelve hours by a gauze tampon.

Bleeding and odor are, for a time, controlled by strong astringent and antiseptic injections. A 1:500 solution of **chloride of zinc** acts both ways, as does **permanganate of potassium**. The strength is limited by the toleration of the vagina and vulva.

Anodynes should be given freely for pain. **X-rays** and **radium** in inoperable cases have been used.

Study of 400 cases of uterine cancer in which **radium** was used. It is more effective for the arrest of the progress of the disease process than any method hitherto used. It is more effective in primary lesions than in recurrences; will occasionally relieve pain in the terminal stages, and will relieve pain, hemorrhage, and discharge, and restore the general health in advanced lesions more effectively than any other agent. It will convert borderland lesions into ones plainly operable. W. S. Stone (Amer. Jour. of Obstet., Mar., 1918).

The application of **heat** of a temperature that will harden but not destroy the tissues destroys the cancer cells, but does not penetrate as deeply as the X-ray and radium (Percy).

CORPUS UTERI.—Three varieties of carcinoma of the endometrium have been described: adenocarcinoma, malignant adenoma, and squamous-cell carcinoma.

The adenocarcinoma is similar to adenocarcinoma of the cervix, and af-

fects the mucous membrane quite extensively before deeply infiltrating.

Malignant adenoma commences as an enlargement and folding of the gland-tubules, while still lined with a single layer of epithelium. The folds of contiguous glands unite and form anastomosing tubules filled with epithelial cells, which begin to proliferate atypically, and gradually distend and break through, to form the ordinary nest-structure of cancer.

Squamous-cell carcinoma may be primary where the epithelium of the endometrium has become squamous, or it is secondary to squamous epithelioma of the cervix.

The uterine wall is slowly invaded, and the glands of the broad ligament and along the internal iliac vessels become infected. Peritoneal adhesions and infiltrations of the broad-ligament connective tissue are formed.

SYMPTOMS.—Watery and bloody discharges, gradually becoming offensive and mixed with bits of broken-down tissue, appear first. Pain is prominent in advanced stages. If discharges and disintegrating masses of tissue are retained, it is colicky in character, but in time the pains of chronic peritonitis assume prominence. Pains shooting into the iliac regions and down the limbs are also troublesome when extensive infiltration exists.

DIAGNOSIS.—The characteristic discharges beginning at or after the menopause, the nature of the pains and the progressive symptoms arouse suspicion. Microscopic examination of tissue brought out by a curette should always be made.

PROGNOSIS.—The prognosis is better than that of carcinoma of the cervix; the surrounding tissues are

not as rapidly infected. An early operation often effects a cure.

TREATMENT.—The only indication is **hysterectomy**. Abdominal hysterectomy would seem to have the preference, since affected glands of the broad ligament and at the pelvic brim can be seen and enucleated. If the surrounding glands are affected the disease may be expected to return, even though the visible ones be removed; hence the only benefit of abdominal over vaginal hysterectomy is that the return may be somewhat slower. Therefore the former is only to be chosen when the conditions are such that the risk would be but little greater: *i.e.*, when the vaginal method presents some unusual difficulties.

Vaginal hysterectomy is performed the same as for carcinoma of the cervix, except that the incisions can be made close to the cervix, and that the Fallopian tubes and as much of the upper portions of the broad ligaments as possible should be taken.

Curettage is only palliative, and should be done with a sharp curette without pressure against the friable uterine walls. **Carbolic acid**, the solution of **perchloride of iron**, or a 50 per cent. solution of **zinc chloride** should then be applied freely in the uterus.

When for any reason hysterectomy cannot be performed, **radium** applied to the endometrium, or **heat**, with an electrode not quite hot enough to destroy the uterine tissue, may be expected to improve the local condition and reduce discomfort.

DECIDUOMA MALIGNUM.—This disorder has been treated under **ABORTION** in the first volume, to which the reader is referred.

Treatment.—The treatment consists in early hysterectomy.

SARCOMA OF THE UTERUS.

—Sarcoma occurs as a papillary or polypoid growth on the cervix, as a diffuse growth on the endometrium, and as an interstitial tumor. It is rare, and occurs at any age.

Sarcoma of the cervix contains round and spindle cells. It is soft and usually papillary, projecting from the vaginal portion until it fills the vagina and exerts pressure on the rectum and bladder. It spreads into the cervix, uterine cavity, connective tissue, and peritoneum about the cervix.

Symptoms and Diagnosis.—The symptoms are abundant hemorrhage and irritating and offensive discharges, retention of urine, difficult defecation, and expulsion of dark-colored, offensive masses. Anemia and cachexia develop sooner or later, pelvic neuralgia and peritoneal pains supervene, and finally death ensues from exhaustion or peritonitis.

The diagnosis is made by the microscope, although youth of the patient, early bleeding, and numerous dark, soft, polypoid masses hanging from the cervix indicate the disease. The hydatid mole does not break down or bleed as easily, and can be traced into the uterine cavity.

Sarcoma of the endometrium is of the round-cell variety, usually diffuse and papillary, and filling the uterus with a soft, brain-like substance that may project into the vagina. The uterine walls become infiltrated, and finally the surrounding organs also.

The symptoms are watery discharges, and later profuse hemorrhage, becoming offensive and mixed with pus. Anemia, septicemia, and pelvic pains become prominent.

The diagnosis may sometimes be made from the abundance of the hemorrhage, character of the tissue that can be scooped out of the uterus, uterine enlargement, and general symptoms of malignancy. Tissue should be microscopically examined.

Interstitial sarcoma resembles intramural myoma in appearance, and consists of round and spindle cells, largely of the latter. It may occur as circumscribed nodules or as a diffuse growth of spindle cells. The submucous tumors sometimes become polypoid. Some are supposed to have been myomas that have undergone sarcomatous degeneration. Rarely they originate in the cervix.

Symptoms.—The symptoms are similar to those of myoma uteri, but they grow more rapidly and are attended later by offensive discharges. Early menorrhagia is apt to be less prominent than in myomas. Pain and general malignant symptoms are tardy.

Diagnosis.—This is made from myoma, on the one hand, carcinoma or sarcoma of the endometrium, on the other. It grows faster than myoma, but does not become very large before it causes symptoms of malignancy. However, it enlarges the uterus more than carcinoma or sarcoma of the endometrium before causing pain, cachexia, odor, etc.

The **treatment** of all forms of sarcoma is **hysterectomy** according to methods described for carcinoma.

HENRY T. BYFORD,
Chicago.

UVA URSI.—*Uva ursi*, U. S. P. Known also as Bearberry, Barren Myrtle, Rockberry, and Mountain-box, is the dried leaves of *Arctostaphylos uva-ursi* (fam. Ericaceæ). It is an evergreen

shrub bearing white or purplish-white flowers and five-seeded bright-red drupes. The leaves are gathered in the autumn.

The important constituents of *uva ursi* are arbutin, ericolin, ericinol, ursone, 5 to 7 per cent. of tannin, and a little gallic acid, resin, and sugar. *Arbutin*, the active alkaloid occurs as neutral, colorless, silky needles, having a bitter taste, and freely soluble in hot water and in alcohol, and sparingly soluble in ether. The mother liquor, left after the removal of the arbutin, contains the yellow glucoside ericolin which yields the volatile oil ericinol. *Ericolin* occurs as a brownish-yellow, odorless, bitter, and hygroscopic powder, soluble in water, alcohol, and alcoholic ether, nearly insoluble in ether, chloroform, and benzin. *Ursone* occurs as silky, tasteless, fusible, and sublimable needles, insoluble in water, dilute acids and alkalies, sparingly soluble in ether and cold alcohol.

PREPARATIONS AND DOSES.

Uva ursi, U. S. P. (leaves). Dose, 20 to 60 grains (0.6 to 2 Gm.) in decoction or infusion.

Fluidextractum uva ursi, U. S. P. (fluid-extract). Dose, 30 minims (2 c.c.).

Arbutin (non-official alkaloid). Dose, 10 to 15 grains (0.6 to 1 Gm.) per diem.

PHYSIOLOGICAL ACTION.—*Uva ursi* has tonic, diuretic and astringent properties. Diuresis is effected by the stimulating action of the arbutin upon the renal epithelium. A small portion of the arbutin is decomposed into hydroquinone and glucose, the former exerting an antiseptic and preservative action upon the urine, and giving it a color varying from light green to dark brownish-green, the coloration becoming accentuated when the urine is exposed to the air. In cystitis, where decomposition of the urine takes place in the bladder, the urine may be of a very dark green when voided. In overdose it may cause nausea, vomiting, and diarrhea.

THERAPEUTIC USES.—*Uva ursi* is used in subacute and chronic inflammations of the urinary organs, being less useful when the secreting renal epithelia are diseased. It is, therefore, more efficient in *pyelitis* and *cystitis* than in *nephritis*. By retarding decomposition of

the urine, and, possibly, by lessening the sensibility of the mucous membrane, it relieves the incontinence, dysuria, and stranguary. In chronic bronchitis and leucorrhœa it has also been used. W.

UVEAL DISORDERS See IRIS, CILIARY BODY AND CHOROID.

UVULA. See PHARYNX AND TONSILS, DISEASES OF.

V

VACCINATION. See VARIOLOID AND VACCINATION.

VAGINA AND VULVA, DISEASES OF.

ACUTE VULVOVAGINITIS.—

This general term includes a variety of inflammations.

Symptoms.—The vulvar symptoms may be summarized into local irritation, throbbing, pain, redness, swelling, heat, and increased secretion. The labia minora may be sufficiently swollen to close the vaginal orifice. The inflamed tissues are first dry, then moist. Painful and frequent urination are very often observed owing to contamination of the urethra and bladder. The gonococcus is often the pathogenic factor in at first apparently benign cases.

Traumatic vulvovaginitis is not infrequent. If the skin or mucous membrane is not broken, ecchymosis of the vulva will mark the injured surface. Pain is almost always prominent, arising from pressure if blood effusion renders the tissues tense.

The hemorrhage may be external or internal and profuse. Swelling is usually a conspicuous symptom, the swollen tissue being soft and compressible when the bleeding has taken place, or hard and firm when due to inflammatory exudate.

Suppuration occurs not infrequently, for the tissues are vascular; while the secretions of the vulvo-

vaginal glands, if retained, during the inflammatory process readily undergo degenerative changes. Uncleanliness and want of care in the treatment predispose to suppuration here as elsewhere.

The vaginal symptoms after traumatism are similar to those of the vulva: pain, swelling, local elevation of temperature, and congestion. Even moderate pressure, introduction of a speculum, or violence of any kind may cause great pain, and more or less bleeding. The acute symptoms may disappear in a few days with judicious treatment. Asepsis is important, especially in cases with suppuration or sloughing.

Etiology.—With the exception of the gonococcus, lack of cleanliness exceeds all other factors as a cause of vulvitis. This is particularly the case in stout women, in whom the defective circulation renders the vulvar tissues unduly liable to infection and irritation, the latter being due mainly to fatty acids developed from excessive local secretion. Poorly nourished and debilitated women are also subject to infection in this region; children likewise. In the latter, any of the infectious diseases may cause it, complicated with ulceration. It may likewise be caused by vaginal discharges, pediculi and other parasites, pathogenic organisms from the anus or urethra, neighbor-

ing cutaneous disorders, the nails in scratching, excessive masturbation or coitus, diabetic urine and the pruritus accompanying this disease.

Traumatic vulvovaginitis may be caused in various ways—falls astride a chair or fence, thrusts from sticks or implements of wood or metal, caustic material (mineral acids, chloride of zinc, etc.), heat from boiling water, from the flames of burning clothes, etc., the horns of angry animals, bites and stings of insects or other animals, etc. Prolonged or complicated parturition, especially if forceps are employed, may also produce it.

Intentional traumatism often produce vulvitis. Among these are the malpractice of abortionists, due to violence and brutality, kicks, rapes, violent coitus, self-inflicted injuries, the latter often in the insane.

Treatment.—Vulvar cleanliness should be insured by **frequent washing** of the parts. A vulvar pad, secured by a T-bandage and kept moist with the **lead-and-opium lotion** (U. S. P.), may be used. A 4 per cent. **solution of cocaine** applied after each washing will serve to assuage the local pain. Excessive irritation or burning is easily controlled by means of a small **ice-bag** applied over the labia. **Absolute rest in bed** is imperative. The pain may also be controlled and sleep insured by using a **suppository** containing **opium**, 1 grain (0.06 Gm.), and extract of **belladonna**, $\frac{1}{4}$ grain (0.016 Gm.). If the healing process is slow, local applications of a 25 per cent. solution of **argyrol** will hasten it. Irrigation two or three times daily with **hot saline solution** (100° to 110° F.) or with **boric acid** (10 per cent.), car-

bolic acid (2 per cent.), **Thiersch's solution**, or **peroxide of hydrogen** will favor the healing process. **Abscesses** and **retention cysts** must be **evacuated** under antiseptic precautions, avoiding opening the venous plexuses at the sides of the vulva.

As regards the vagina simple measures and gentleness of manipulation will be helpful. Douches with **hot saline solution** or weak **solution of lead and opium** (U. S. P.), twice daily, will serve the double purpose of cleanliness and relieving pain. In the interval a **pad of absorbent cotton** may be secured against the vulva and kept moist with the lead-and-opium wash. The bowels must be kept open with salines or any approved **mild cathartic**. **Rest in bed** will hasten the end of the inflammatory process.

If there should be elevation of temperature (102° F.—38.9° C.—or higher), **quinine** in 10-grain (0.6 Gm.) doses may be given at night. The **diet** must be composed mainly of **fluids**. If these hygienic precautions are observed the course of the disease may not exceed a week. If the malady does not yield to the above treatment, a solution of **zinc sulphate** or an application of **protargol** is advisable.

CHRONIC VULVITIS.—This disorder may follow the acute form, but is milder as to swelling and redness at first. Irritation and redness gradually become severe, however, with intense pruritus and burning. After a time the vulvar tissues may be **edematous**, **parchment-like** or **hard**. In other cases there is present also:—

Follicular Vulvitis.—In this disorder the sebaceous and sweat glands and the hair-bulbs are inflamed and stand out in **small, red, elevated masses**,

above the more or less inflamed basal tissues.

The follicular openings may close, the follicles becoming distended; or they may form abscesses, which discharge offensive pus.

Glandular Vulvitis.—**Bartholinitis** is due usually to extension of an adjoining morbid process to both Bartholin's glands. According to Snger, a reddish areola around the openings of the ducts in the fossa navicularis suggests gonorrheal infection. When pus is formed there is acute pain and heat, the gland being enlarged and red. When mere effusion occurs, a cyst is formed.

The urethral crypts around the meatus urinarius may also become inflamed from the same causes, but especially at menopause and coincidentally with senile vulvitis. Pruritus and burning occur along with the other symptoms of vulvitis.

Treatment.—The antiseptic and surgical measures indicated for acute vulvitis (*q. v.*) sometimes suffice. Pruritus is so important and distressing a symptom that a special section is devoted to it (see page 778). When these measures fail, **removal or cauterization of the affected glands** is necessary. Chronic suppuration requires **free incisions** and **iodoform packing**, the wound being allowed to heal from the bottom.

In the senile form, Dolris advises that cotton dipped in the following be passed over the entire vaginal mucosa:—

R *Tinctura iodi* ʒiiss (6 Gm.).
Glycerini ʒv (20 Gm.).

M.

A cylindrical tampon covered with the following ointment should then be inserted into the vagina:—

R *Zinci oxidi* ʒiiss (10 Gm.).
Petrolati ʒvj (25 Gm.).

M. Fiat unguentum.

Each time the tampon is removed an injection of the following is made:—

R *Liquoris plumbi sub-acetatis diluti* ʒvj (24 c.c.).
Aqua bull. Oij (1000 c.c.).

M.

The zinc oxide ointment and the injections should be used daily, and the iodized glycerin applications made every two or three days.

GNORRHEAL VULVOVAGINITIS.—This condition, due to gonococcus infection, is attended by very acute inflammatory symptoms, which are apt to come on suddenly, in from one to seven days after exposure. The tissues are hot, dry, and swollen, and are the seat of sharp burning pain, extending to the urethra, which seldom escapes infection.

A common accompaniment is inflammation of the vulvovaginal glands. The infective process extends from the duct, which is occluded in some instances, while in others it is the avenue for the escape of exuberant secretion. Suppurative inflammation of the cellular tissues and abscess of the vulva are common.

Gonorrheal infection, owing to its remarkable tendency to spread throughout the entire genitourinary tract, is one of the most destructive disorders to which woman is exposed. The inguinal glands may also be infected, and suggest syphilitic bubo. A more or less marked chill, a rapid pulse, etc., are common. The pain soon extends to the deeper tissues, the bladder, rectum, perineum, etc.

Diagnosis.—This should be based upon microscopic examination of

smears for the gonococcus. The gonorrhea complement-fixation test (analogous to Wassermann test, *q. v.*, page 385, fifth volume) is another valuable method of detection.

Distinction from local syphilitic lesions is important. (See also article on *SYPHILIS*, this volume). In *syphilitic vulvitis* the initial lesion may be on any portion of the skin or mucosa. It may be very small and featureless. It is often hidden within the navicular fossa or on the inner side of the vulva, and may be overlooked. Acute inflammatory symptoms apart from those with the sore or sores are not frequent, and may not appear in the vulva at all. The neighboring inguinal glands are at times enlarged and painful. The erythematous eruption of syphilis is often seen upon the vulvar skin, while the late ulcerative lesions are relatively rare. Syphilis and gonorrhea not infrequently co-exist.

Etiology.—Gonorrheal vulvitis, due to the gonococcus, notable for its vitality and power to remain inactive in crypts and to resume activity when communicated to another individual, results almost solely from coitus. Communication by means of towels and water-closet seats is apt to be questionable. Washing with infected cloths or sponges, contact with hands of nurses who have just handled infected bandages, have also been incriminated. The disease may occur at any age. I have seen it in the little child and in the toothless dame of three-score and ten. The tissues of women between the ages of 20 and 30 are the most susceptible to its influence. In very young children the poisonous agent is often conveyed by the hand of the infected mother when

the child is washed or dressed, or from contact with an infected father or mother while in bed at night.

Treatment.—This should include frequent ablutions or douchings with hot water (100° to 110° F.). For local applications the best agent is a solution of silver nitrate, the affected surface being freely and often covered with it. Protargol has been introduced as a substitute for the silver salt, and is very effective.

For internal treatment a ferruginous tonic may be given or a combination of quinine, strychnine, and gentian. Vaccines have been tried, but their value is still problematical.

Prophylaxis is important in infants to prevent spread to deeper organs. A good method is that of Chapin, who found that by using vulvar pads of cheesecloth on all girl babies in wards, placing the soiled pads in bags, to be immediately sealed and burned, and employing individual thermometers, gonorrheal vaginitis can be reduced to a minimum. The eyes and other organs are rarely infected. Most cures are spontaneous.

INFECTIOUS VAGINITIS.

—The venereal variety being treated in the article on *SYPHILIS*, and in that on the *URINARY SYSTEM (GONORRHEA)* in the present volume, this section includes only the remaining forms.

TUBERCULOUS VULVO-VAGINITIS.—This is one of the rarest forms of tuberculous disease, rarely isolated, being usually an element in disseminated tuberculous infection. It may be communicated in coitus from a tuberculous penis.

Symptoms.—On the vulva tuberculosis is characterized by a painless ulcerative eruption of the labia, especially the labia majora, which shows

the usual features of tubercular processes: sloughing, want of tendency to heal readily, and scarring and contraction after healing. It is probably identical with lupus of the vulva.

In the vagina the morbid process is that of miliary tubercle upon mucosæ in general, the tubercle being a lenticular mass varying in size from a pin's head to a pea, slightly raised, grayish, breaking down and forming a ragged ulcer with infiltrated walls. Neighboring ulcers frequently coalesce and show but little tendency to heal. Tubercles may be few or the vagina studded with them. They are painful to the touch, secrete a sanious discharge, which excoriates tissues, and should be differentiated from the ulcerative lesions of venereal vaginitis.

Acute local symptoms are usually wanting. The many avenues for transmission to other parts must not be forgotten, nor the ease with which general infection may follow.

Treatment.—Constitutional treatment embraces such means as are usually administered in tuberculosis: **iron, oxygen, creosote, codliver oil, alcohol**, and an abundance of **nourishing food**; local treatment includes cleanliness, **creolin douches** (1 or 2 per cent.) twice daily, and local applications of a 10 per cent. **solution of silver nitrate**, or of the **mineral acids** in moderate strength. The object of local applications is to stimulate the tissues to healthy activity and prevent spreading of ulceration, *not* to cauterize the tissues. The following formula will be found useful:—

R *Creosoti*,
Ichthyol. ʒʒ ʒss (2 Gm.).
Ung. zinci ox. ʒj (30 Gm.).

M. Sig.: Apply freely.

DIPHTHERITIC VULVO-VAGINITIS.—There forms a grayish, sloughy, fibrinous false membrane, attended with the usual symptoms of acute inflammation. It may occur either in children or in adults. It has been observed in connection with pharyngeal diphtheria, with the eruptive fevers, and with puerperal septicæmia. It is a symptom of grave import, indicating a septic condition that is usually profound and general.

Treatment.—The constitutional treatment must be that of the general disease. **Antitoxin** is indicated if the bacteriological examination shows the Löffler bacillus. Helpful as supporting agents are: **iron** in an assimilable form (**Blaud's pills**, the **peptomanganate**, tincture of the **chloride of iron**, etc.), **strychnine, quinine, milk**, and broths. Locally, one should obtain perfect cleanliness. When the membrane begins to disintegrate or exfoliate, it should be gently removed with dressing-forceps, and hot antiseptic **douches** (**creolin**, 2 per cent., at about 100° F.) given twice daily.

In the diphtheritic vulvovaginitis of children and virgins it is desirable to avoid entering the vulva, but a pad of absorbent cotton may be kept constantly in contact with the vulva moistened with **chlorine-water**, or a 10 per cent. **solution of silver nitrate**, or a 5 per cent. **solution of hydrochloric or carbolic acid**. For puerperal women and multiparæ in general, vaginal **douches** of **creolin** (2 per cent.) may be used, with great gentleness, twice daily, while in the intervals the vulvar pad moistened with the 10 per cent. **solution of silver nitrate**, or 2 per cent. **solution of protargol**, should be applied.

PUERPERAL VULVOVAGINITIS.

—This may follow injuries of the vagina during parturition, especially instrumental deliveries; the strangulation of tissues resulting from ligatures applied during the repair of tears; cauterization, and other trauma. It may occur among rich or poor, but especially in manifestly dirty surroundings, and where doctors or midwives are careless. It sometimes occurs, however, when precautions of doctor and nurse have been most rigid and complete.

The infecting material may be received in the vagina itself or in the vulva or uterus. It may convey the streptococcus or the mixed streptococcus and staphylococcus, or the enterococcus, as observed by G. E. Shoemaker, or organisms of lower virulence. The local vaginal symptoms may not be acute, for the disease is seldom limited to the vagina, or there may be the symptoms of an ordinary infectious vaginitis.

Treatment.—The best is a 2:1000 solution of **potassium permanganate** as douche, with local application of 20 per cent. **argyrol** daily, leaving a small tampon wet with it in the canal. A stronger solution may be used to swab the latter if no tampon is left in. Scrupulous cleanliness is important.

The *chronic granular vaginitis of pregnant women* is very refractory. The utility of **zinc-oxide ointments** is practically limited to relief from pain. Treub advises injections of **alum**, 1 tablespoonful in a quart of tepid water, or of 1:4000 solution of **potassium permanganate**. Doléris recommends that a diluted **mercurial ointment** be applied to the vagina daily on a gauze or cotton tampon:—

R *Unguenti hydrargyri*... ʒij (8 Gm.).
Adipis lane hydrosi... ʒvj (24 Gm.).
 M.

Where complete recovery from the vaginitis has not occurred at the advent of labor, an **iodine application** should be at once made to the cervix, the vagina and vulva washed with soap and tepid water, and **antiseptic vaginal irrigations** conducted.

ECZEMATOUS VULVOVAGINITIS.—This disorder runs no well-defined course. There is an acrid watery discharge, which excoriates the external genitals, causing distress and persistent itching. The latter may extend to the vulva and perineum; the vaginal mucosa may be sensitive and congested, and attempts to relieve it by friction often intensify the irritation.

The discharge and irritation may extend to the uterine mucosa.

Etiology.—The condition usually occurs after the menopause. It has often been called senile vaginitis. It is almost invariably associated with eczema of the vulva, which is irritated by an acrid vaginal discharge, especially in cold weather and at night. The itching in such cases is almost intolerable—*pruritus vulvae*. Scratching and rubbing cause great disturbance in the skin, which may become dry and hard, like parchment, or may exude an excoriating serum. Probably germs from dirty fingernails are frequently communicated, thus complicating the condition. The suffering may cause hysteria or even insanity.

In my experience it is quite a common disease, chiefly among those not overparticular in personal habits.

Treatment.—Cleansing of the vagina with 10 per cent. solution of

silver nitrate applied upon a swab of cotton to *every portion of the mucous membrane* is required. An ample tampon of cotton-wool moistened with a **glycerin and bismuth paste** should then be placed in the vagina. Applications must be made daily until congestion and discharge have ceased, and sedative and astringent douches should be used daily before the tampon is renewed. Any constitutional symptoms should likewise receive especial attention.

The entire inflamed surface of the vulva should also be covered with the **bismuth and glycerin paste**, applied freely and frequently, the vagina being plugged with cotton-wool moistened with it. This treatment, in addition to vaginal douches sufficiently astringent (**tannic acid**, **alum** or **hydrastis** combined with hot water), and **cathartics** at night (compound cathartic pills, 1 or 2; or **fluid-extract of cascara**, 1 dram—4 Gm.), will usually succeed, and must be continued as long as any symptoms remain.

LEUCORRHEA.—By this term is meant a liquid discharge, more or less sticky and purulent, milk-like, variable in quantity, and sometimes offensive. It may occur at any age. Vaginal discharges from conditions already described are excluded. The condition which causes the discharge is not an inflammatory, but an irritative one, in which there is excess of secretion from the vaginal epithelium, and probably transudation of serum and corpuscles from the vaginal blood-vessels, at least in some cases. The discharge is the more profuse as the tension in the blood-current is increased; therefore just before and after menstruation,

Symptoms.—While leucorrhœa is a symptom, it is also the direct expression of a diseased condition, and produces a variety of unpleasant results. The daily discharge may amount to several ounces. It may also produce an intense irritation of the vulva and skin which it soils, causing almost unbearable itching and pain.

Etiology.—Causes: (1) Conditions in which the freedom of the pelvic circulation is impaired; *e.g.*, pregnancy, new growths, and inflammatory conditions within the pelvis. (2) A relaxed and catarrhal condition of the mucous membranes in general; *e.g.*, anemia, fatigue, and the catarrhal diathesis. (3) Frequent coitus.

Treatment.—The treatment consists first in **cleanliness**, the discharge being received upon absorbent-cotton pads as soon as voided; next in relieving the causative conditions; and, finally, using **astringent douches**.

In the writers' treatment of leucorrhœa, a tablet of **lactic acid bacilli** is slightly moistened, inserted into the upper vagina through a speculum, and smeared over the surface. The treatment is repeated at first weekly, later once a month. Non-specific vaginitis in children usually responded well to the treatment. Of cases in women without a gross pathologic condition, about one-half responded well. Best results in senile vaginitis. Block and Llewellyn (Jour. Amer. Med. Assoc., Dec. 15, 1917).

In some cases of leucorrhœa in young girls **bathing in tepid alkaline water** containing, *e.g.*, $\frac{1}{2}$ pound (250 Gm.) of **sodium carbonate**, or local washings with a 1 per cent. **borax solution**, or, if the inflammation is severe, with a 2 per cent. **decoction of althea root**, may suffice to give relief. In women in whom these measures are not promptly effective,

douching should be advised, either with normal saline solution, if there is no inflammatory process locally, or with the borax solution just mentioned, or a 1 per cent. decoction of saponaria root. Where greater astringency is necessary, injections of oak bark (5 per cent.), krameria (3 per cent.), or eucalyptus (1 per cent.), with sodium borate added, may be used. For very obstinate cases a 0.5 per cent. solution of copper sulphate, 1 per cent. solution of lead acetate, or the following combination, recommended by Pringle, may be used:—

R *Zinci sulphatis*,
Aluminis ex.āā ʒiiss (10 Gm.).
Aque Oj (500 c.c.).
 Fiat solutio.

Where more or less odor attends the leucorrhœal discharge some preparation containing sodium hypochlorite should be used.

ATROPHY OF THE VAGINA AND VULVA.—Atrophy of the vagina is the result of age, but a diseased condition when it occurs prematurely, or as the result of other diseased conditions. It occurs after oöphorectomy and premature menopause; sometimes in connection with excessive obesity and wasting diseases, which cause atrophy of all the genitals. The vaginal lumen is contracted, the mucous membrane is pale, and its vitality as a functioning organ is practically abolished. No particular treatment is indicated, its work as an organ being terminated.

Atrophy of the vulva also attends old age, the hair of the labia becoming sparse and straggling, the labia majora flabby or still somewhat prominent if the supply of fat is abundant, the labia minora small and

insignificant, while the vulvovaginal glands lose their activity. This state may also come prematurely as the result of general failure of nutrition or removal of the ovaries. It is not a customary result, however, of early removal of the ovaries.

HYPERTROPHY OF THE VAGINA AND VULVA.—Excessive use causes hypertrophy of the vagina. Its walls may merely be thickened or be disposed in folds and ridges. The condition may be due to excessive child-bearing, excessive coitus, or to an accumulation of fat and connective tissue, which is part of a general process. If unattended by prolapse it may cause no symptoms.

Hypertrophy of the vulva is rather common. It may involve the labia majora or minora alone, or both. In syphilis and chancroid it is frequent, the labia majora being that more often implicated. The degree of enlargement varies; it may be moderate, or the vulva may be four or five times its normal size. The skin is hard and board-like to the feel. Hypertrophy of the labia minor is also very common. Among the negroes of Africa it is said that the enlargement is sometimes enormous, the labia hanging down in great folds and masses—often due to elephantiasis.

A common cause is masturbation, the nymphæ being very sensitive and constant friction and traction causing elongation and enlargement.

Treatment.—When hypertrophy is a source of great discomfort, owing to its location, operative removal will become necessary. When the tension of the skin is marked, shallow linear incisions, by depleting the tissues, will afford relief; leeches likewise.

PROLAPSE OF THE VAGINA.

—This condition of the vagina is usually associated with hypertrophy. The anterior or the posterior wall, or both, may be prolapsed. The conditions which cause hypertrophy are also usually the cause of prolapse.

Treatment.—Palliative treatment consists in the use of **pessaries, electricity, or astringent substances.** But the moment the treatment is discontinued the unfavorable conditions will recur. Hence radical **surgical measures** are to be recommended, namely, the removal of superfluous tissue and the restoration of the vagina to its normal condition. For prolapse of the posterior wall the simplest, oftenest applicable operation is **Hegar's method.** It consists, in brief, in the removal of a triangular, or nearly triangular, strip of mucosa, the apex of which is near the os uteri and the base at the introitus vaginæ. Its size varies with the prolapse and width of the vagina.

For prolapse of the anterior wall an operation devised by myself many years ago is effective. In extensive prolapse, an elliptical strip of mucous membrane is removed from the long axis of the vagina, the vaginal wall being depressed with a sound (as in Hegar's operation on the posterior vaginal wall) to determine the extent of removal. Then another ellipse, sufficiently large, is removed at right angles to the first, the plane of each ellipse cutting that of the other at its middle. With suitable precautions against hemorrhage, the edges of each quadrant (or half-ellipse) in the depuded area are then united from end to center with aseptic catgut, the ends being carefully tied to close with neatness the central por-

tion of the wound. Iodine collodion is then applied to the wound and iodoform-gauze dressing in the vagina. Upon rest in bed for ten days and perfect cleanliness, the wounds usually heal by first intention.

Hernial protrusion of the uterus, bladder, and rectum, either singly or in combination, has taxed the operative ingenuity of gynecologists. Even after removal of the uterus there has been a recurrence of the cystocele. G. M. Edebohls, after four other operations on the same patient, had failed to sustain the bladder within the vagina, **removed the whole vaginal mucosa, permanently closing the vagina by columnization,** and cured his patient. Subsequently he reported having had 8 successful cases; Waldo had 3 cases, and Boldt 2 cases. Gallant also had 2 cases.

VAGINISMUS.—This term is applied to an excessive degree of hyperæsthesia, together with spasm of the muscles which form its outer wall, and which render any contact with the vagina annoying or even positively painful. It may often be referred to the sensitive remains of the hymen, which may not bear the slightest pressure or even suggestion of pressure without exciting painful emotion and spasm.

Treatment.—The induction of general anesthesia, **dilatation** of the introitus vaginæ and **excision** of the ring of tissue which is the remnant of the hymen will usually cure the trouble. Hemorrhage may be profuse, and it is always desirable to tie all bleeding vessels and insert a tampon filling the entrance of the vagina. A tampon moistened with a 10 per cent. solution of cocaine is useful to anesthetize the introitus temporarily.

VAGINAL FISTULÆ.—Fistulæ may communicate with the bladder, uterus, ureter, intestine, rectum, or pelvic connective tissue. Often the result of prolonged, difficult labor, they may also result from sepsis following surgical operations and pelvic inflammation. Ureterovaginal and uretero-uterovaginal fistulæ are rare; so also is uterovaginal fistula, the latter following rupture of the uterus. Enterovaginal fistula may follow hysterectomy, removal of the appendix, or any complicated pelvic operation in which the intestine has been injured. This form of injury has become more frequent since the removal of diseased structures by way of the vagina became an approved procedure.

A vaginal fistula implies the passage of urine, feces, or pus into the vagina by way of a canal connecting with the bladder, intestine, or an abscess within the pelvis. It is a very distressing condition. Obliteration of this canal is usually difficult and subject to frequent failures.

Treatment.—A cure will sometimes result spontaneously; if not, it is obtainable only by **surgical measures.**

Two classes of cases may be considered: those in which the fistula alone is to be regarded and obliterated, and those in which this procedure alone will not suffice, the organ, abscess, tissue communicating with the vagina requiring separate treatment or removal.

In the first class may be mentioned the fistulæ communicating with the bladder, rectum, ureter, and some with uterus, intestines, and pelvic connective tissue. In the second class are those which connect with the tubes and ovaries, intestine, ap-

pendix, and pelvic tissue. The first class of cases require that the mucous membrane of the vagina be carefully and broadly denuded, the adhesive attachment between the vagina and the other injured organ being usually maintained. The denuded tissues are then brought into such accurate apposition that no leakage can occur. For suture material in such cases nothing, I believe, is equal to fine, pliable, silver wire. Each suture is carefully twisted so as to furnish a splint to the healing tissues, but care must be taken that it be not twisted too tightly, thereby defeating its object. The sutures are to be retained from seven to ten days. In vesicovaginal fistula it has always seemed to me rational to keep a catheter in the bladder for constant drainage until the wound has healed.

In the second class of cases, not only must the vaginal opening be closed, but the abdomen opened and the offending organ or tissue removed. In some cases this removal will suffice, the vaginal fistula being closed by a subsequent operation should it fail to heal. In either class of cases a series of operations may be required, and great patience and skill demanded to obtain a cure.

Mayo's Technique.—C. H. Mayo (Trans. West. Surg. Assoc., Dec., 1915) has described the operation successfully employed by him for the past twenty years in the repair of small vesicovaginal fistulæ: An incision is made through the vaginal mucosa extending completely around the fistulous opening for about a quarter of an inch, or less, from its margins. The vaginal mucosa is dissected toward the opening, care being taken not to break through at the margin.

This makes a little cup or funnel-shaped opening projecting into the vagina. The circular dissection is carried deeper around the fistula, approaching no nearer than one-eighth of an inch to the margin, its depth penetrating to the mucosa of the bladder, but not through it. This leaves a little bell- or funnel- shaped opening with mucous membrane which is connected with the mucosa of the bladder and projects into the vagina. A ligature carrier is passed through the urethra into the bladder and through the fistula into the vagina. A suture is passed through both walls of the funnelled mucosa on each side of the ligature carrier. The two ends of the silk suture are threaded into the ligature carrier, which is withdrawn from the bladder and urethra. The ends of the suture projecting from the urethra are drawn upon, and with a little aid the fistulous tract starts inverting. As soon as the mucosa disappears a circular suture of fine chromic catgut is applied, a little more traction is used on the ends of the long suture, and a second purse-string suture of catgut is applied. The vaginal side is then closed either by a circular suture of the chromic catgut or by interrupted sutures as seems best. This inversion turns the mucous surface into the bladder and leaves a healing surface within the tube. One of the long ends of the suture projecting from the urethra is rethreaded and by a needle is sutured to the skin of the labia. The two ends are tied at this point, making slight traction. A self-retaining catheter (Pezzer type) is inserted into the bladder, and the patient told to rest on her side or face, to obviate urinary pressure on the fistulous area.

After four days it is necessary to watch the catheter carefully to see that sediment or phosphatic deposit does not obstruct its lumen. In some cases irrigation is necessary. However, the long suture attached to the inner side of the fistula and passing through the urethra acts as safety valve if the catheter becomes temporarily plugged. After a week the repair is usually solid, but it is better to keep the patient on her side or face for a few days longer, and during this time keep a catheter in or pass one at regular periods. The suture from within the bladder either cuts itself out with the slight traction or it may be drawn out by cutting one side where it is attached to the skin.

TUMORS OF THE VAGINA AND VULVA.—Vaginal tumors may be benign or malignant:—

Benign.—(1) Herniæ. (2) Cysts. (3) Hematomata. (4) Non-cystic growths. (5) Foreign bodies.

Malignant.—(1) Carcinomata. (2) Sarcomata.

HERNIÆ.—Prolapse of the vagina is often associated with one or both of two forms of hernia. Distinction between them is often overlooked. These consist of hernia of the rectum, or rectocele, determined by the finger or sound in the rectum, and hernia of the bladder, or vesicocele, similarly determined by a sound within the bladder. Hernia at the top of the vagina is determined by the presence of a soft, painless, movable tumor, which combined palpation proves to be a process of the intestine.

Herniæ within the vagina may be due to descent of the bladder, rectum, or intestine. The first two are usually the result of parturition, and are

common among multipara who work hard, and bear heavy burdens. In the third form the intestine descends through the top of the vagina after the uterus has been removed, or an incision has been made in the anterior or posterior fornix. In rare cases a prolapsed intestine in Douglas's pouch has been forced through the vaginal fornix by a sudden impulse or by continued straining independently of any surgical procedure.

Hernial tumor of the *vulva* may result from prolapse of an ovary or from descent of the intestine through the inguinal or femoral canal into the labium majus. The differentiation of the causes of hernia is not always possible, and when operating for this condition it is well to remember the desirability of returning a healthy ovary to the pelvic cavity. The prolonged ovarian ligament may be shortened by looping it upon itself to prevent recurrence of the prolapse.

Hydrocele of the round ligament will, in some instances, simulate intestinal hernia, and must be distinguished from it in the plan of treatment. The contents of such a tumor are, of course, to be evacuated and a portion of the tumor-wall removed to prevent possible recurrence.

Treatment.—Relief is surgical. The measures mentioned under vaginal prolapse may be used for rectocele and vesicocoele, while for the hernia at the top of the vagina the patient may be placed in the left lateral posture with the hips elevated. The tumor can then be reduced, if possible, with the finger. A sufficiently large portion of the prolapsed vaginal mucous membrane is then dissected away; the sac of the hernia opened, cleared by careful manipulation of its

contents, if it has any, and cut away; the edges of the peritoneal stump brought to the edges of the vaginal wound; and the tissues all closed with interrupted sutures, worm-gut being preferred for this purpose. Instead of this procedure, one may follow **Thomas's method**: open the abdomen, draw back the prolapsed omentum or intestine out of the sac, draw back and excise the sac, and close the wound with silk or catgut. After this the prolapsed portion of the vagina may be excised and the wound sutured. The **Bassini operation** offers good prospect of radical cure for hernia in women.

CYSTS.—Cysts of the vagina are not infrequent. They may occur singly or there may be several. They may be retention cysts, containing lymph or mucus to which blood may be added by vascular rupture.

Purulent degeneration may follow. An abscess and cyst of the vagina may also result from a hematoma, or from a tumor within the pelvis (pelvic abscess, cyst of the broad ligament, etc.) which communicates with the vagina by means of a sinus or fistula.

These cysts seldom attain any great size, and they are not usually painful, except when connected with severe lesions of the pelvic organs.

Treatment.—The uncomplicated cysts may be ligated at their base and excised, or if too deep-seated for ligation, they may be exposed by incision in the vagina and dissected out. If connected with a tumor of the pelvis, this must first be removed.

HEMATOMATA.—Hematomata of the vagina and vulva are rare. Thrombosis in a vaginal vessel, with rupture and blood-tumor, while con-

ceivable perhaps as an accident of labor, is at least improbable. As a result of pressure or bruising, or violence with instruments during labor, it is quite possible.

Other accidents may account for it, e.g., violent coitus, masturbation with wooden or metallic substances, falls astride a fence or a chair, or a thrust with any hard object. It is possible also as an accompaniment of purpura hemorrhagica. No age is exempt. The tumor may be little more than an ecchymosis or slightly elevated effusion, or may occupy a large part of the vagina. The causal hemorrhage is usually self-limited, owing to pressure of the surrounding tissues.

Treatment.—There is little to be done; the fluid contents of the tumor are usually absorbed if not disturbed. Should purulent degeneration take place, the tumor would require to be treated as abscesses elsewhere. Rest in bed will favor absorption, and warm boric acid compresses favor resolution.

MISCELLANEOUS GROWTHS.

—Benign neoplasms of this class are most frequently fibroids or outgrowths from the mucous membrane. *Lipomata* have rarely been reported.

Fibroids may be either sessile or pedunculated. They are always sessile in their early history. They may be projected into the vagina from the uterus or originate in the vagina, are seldom larger than a walnut or small egg, and are painless. They may be pure connective-tissue growths or contain muscle-elements. Little is known as to their causation.

The mucous-membrane growths, or *polypi*, are always pedunculated; they may be single or multiple, are always painless, but may give rise to hemor-

rhage and a mucoid or mucopurulent discharge; they are seldom larger than a pea.

Treatment.—This consists in ligation and excision of the polypi; incision and enucleation of the sessile tumors.

FUNGIOUS GROWTHS of the vagina must be rare. Garrigues refers to two forms, which usually occur among pregnant women. They are known as *Leptothrix vaginalis* and *Oidium albicans*. The chief symptom is itching, especially with *Oidium albicans*. The vaginal mucosa is red and inflamed, and studded with small, whitish growths similar to those in the mouths of children afflicted with the same fungus. The distinguishing growths are determined microscopically.

Treatment.—A silver-nitrate solution (10 per cent.) or a 10- or 15-per cent. solution of copper sulphate or of lead acetate may be swabbed freely over the vaginal mucosa daily until it has returned to normal.

FOREIGN BODIES.—These may become fixed in the vagina and be more or less surrounded by new tissue, and so become essentially tumors. They may consist of hair-pins, pieces of glass, pessaries long neglected and overlooked, etc. They are often introduced for the purpose of masturbation, and sometimes from mere perversity. Intense inflammation may result. They may form a focus from which malignant disease develops.

Treatment.—Foreign bodies may cause intense pain. In some cases they may be removed with forceps; in others, dissection is necessary.

MALIGNANT GROWTHS.—Of these, *sarcoma* is rare. It consists in

an infiltration of the vaginal wall, is very painful, and its presence can only be determined by excision of a portion and microscopic examination.

Carcinoma is also, for the most part, an infiltration process. It may be an extension from carcinoma of the uterus; in fact, the disease rarely originates in the vagina. The tissues involved may be hard or soft, and bleed readily. The condition sometimes results from irritation by a pessary or a foreign body in the vagina.

Leucoplakia of the vagina should be classed among malignant tumors as it nearly always passes into cancer.

Rhabdomyoma, occasionally met in the vagina of infants as rapidly growing polypoid masses, may also assume a malignant type.

Treatment.—This consists in early, extensive removal with knife, scissors, or actual cautery. In some cases the diseased tissue can be removed only by scraping with the sharp curette. Recurrence is almost certain unless the entire growth is removed in its incipency. Radium has been recommended.

CONGENITAL ABSENCE.—

This condition is rare; it signifies arrest in the development of Müller's ducts during embryonic life from causes of which we know very little. It may coexist with perfect development of all the other genital organs. There are no troublesome symptoms if there is also absence of the ovaries; nor before puberty, as a rule, nor after the menopause. Trouble is usually due to the accumulation of menstrual blood within the uterus. I have seen the resulting tumor extend nearly to the umbilicus in a girl of 16.

Treatment.—When at puberty the elimination of the menstrual flow is

prevented, the uterus can be reached by way of the rectum, and the blood then evacuated. In a case reported by Fordyce (*Edin. Med. Jour.*, Aug., 1912), the menstruation appears to have found its way into the peritoneum at regular intervals, and to have undergone rapid absorption therefrom. Having suffered acute abdominal pain in one instance, the girl was operated on for appendicitis. The hemorrhage was traced to an unusually vascular Graafian follicle.

A more scientific procedure is the construction of an artificial vagina. It is essential to provide the artificial vagina with a mucous membrane. The operative procedure devised by Baldwin, of Columbus, O., proved eminently successful in his 6 cases. A transverse perineal incision is made between the bladder and the rectum. Dissection is carried up to the peritoneum. Through an incision in this a piece of the small bowel about 25 cm. long, 30 cm. from the ileocecal junction, is brought down, cut across, and the ends are inverted with a purse-string suture. The continuity of the rest of the bowel is re-established. The center of the detached loop of bowel is caught with a clamp, and drawn down into the vaginal canal, leaving the two ends flush with the floor of the pelvis. The abdomen is closed, and the portion of bowel held by the clamp is opened and each side wiped out, and packed with iodoform gauze, so as completely to fill the vaginal space, and the edges are attached to the margins of the perineal opening. After three weeks, the septum between the two loops is crushed, thus leaving but a single vaginal opening. Several surgeons have resorted to Baldwin's method, all

with success. All cicatricial contraction is also avoided.

The lower end of the rectum, above the sphincter, has also been used to supply a vaginal canal. The possibility of complications from the colon bacillus would, however, seem increased.

Conversely, a *double vagina* may occur and its presence be detected only during parturition. This condition may be simulated by a longitudinal vaginal septum. Such a septum may occur across the vagina, and thus form a *secondary hymen*.

Adhesions.—Inflammatory disease of the vagina (erysipelas, diphtheria, sequelæ of severe labor, etc.) may cause extensive sloughing and exfoliation of the mucous membrane, followed by complete adhesive union of the anterior and posterior walls.

Acquired Occlusion.—Complete closure by surgical procedure has been recommended, e.g., for extensive and inoperable vesicovaginal fistula—the menstrual fluid being discharged through the bladder.

Acquired defects of the vagina may also consist in narrowing or atresia after unsuccessful operations, after inflammatory diseases with sloughing or necrosis, after severe labor, after cauterization from heat, acids, etc., as injuries or malignant infiltration, and as the consequence of senile atrophy or premature menopause.

Atresia from the last two causes is usually irremediable. When due to other causes it may sometimes be overcome by judicious dilatation and the cutting of bands and strictures.

VARICOCELE.—This sometimes accompanies pregnancy. It implies obstructed venous circulation. The venous supply of the vulva is exten-

sive; hence any condition increasing pelvic pressure may derange venous circulation. Fibroid tumors of the uterus, tumors of the ovaries and tubes, pelvic abscess, pelvic peritonitis and cellulitis, and subinvolution of the uterus may all cause enlargement in the veins of the vulva. In the later months of pregnancy this enlargement is sometimes enormous, and rupture is constantly imminent. Occasionally rupture does occur, either just before or during labor, and hemorrhage, phlebitis, or thrombosis occur, with grave possibilities.

Treatment.—Rest in bed and a pressure bandage upon the enlarged vessels. A pad of absorbent cotton moistened with an astringent solution (tannic acid, alum, or fluidextract of hydrastis) may be worn until the cause of the pressure can be removed; the varicocele then usually disappears.

PARASITIC VULVITIS.—Various degrees of inflammation result from vulvar parasites. In children, worms (*lunbrici*, *ascarides*) whose habitat is the rectum, sometimes migrate to the vulva and cause much uneasiness.

Pediculi pubis are common after puberty, the hair-follicles upon the labia and mons veneris being attacked. Intense itching, with consequent scratching and rubbing, results. The inflammatory reaction is very decided, the vulva being sometimes converted to a mass of suppurating sores.

Treatment.—The treatment involves cleanliness and great gentleness of manipulation. Irrigation with a 2 per cent. solution of creolin should be practised twice daily. The hair of the vulva should all be carefully

clipped away, and the entire surface freely anointed with **mercurial ointment** (*unguentum hydrargyri*). After the parasites have been destroyed the inflamed surface may be kept constantly covered with the official **zinc ointment** until healing has occurred.

KRAUROSIS VULVÆ.—In this rare condition, characterized by atrophic contraction of the vulva, the latter appears dry, shrunken, tense, and glistening, resembling scar-tissue. The surrounding hair becomes thin and dry, and gradually drops out. The vestibular skin is studded with ecchymotic, reddish-brown, depressed spots, although itself pale and deficient in pigment, followed by abrasion and cracking, and in some cases by a purulent discharge. It is attended by itching, burning, and sometimes much pain. It may lead to local cancer.

Its causes are obscure. It is mainly witnessed in elderly women, and appears related to senile involution. It has also occurred, however, in younger women, after removal of the ovaries. Longyear found a band of fibrous tissue in lieu of the subcutaneous connective tissue, and believes that it impairs nutrition of the vulvar tissues by strangulating their vascular supply. It was formerly attributed to syphilitic infection, but the Wassermann reaction has proved this to be untrue. Nor can it be attributed to gonorrhea or sexual excesses. In a case of Balzer and Laudesmann it was associated with lichen atrophicus.

Treatment.—Spontaneous recovery is rarely witnessed. **Removal** of all the superficial diseased tissues, including the fibrous band referred to above, is recommended by Longyear.

Case of kraurosis vulvæ in which the writer performed the following

operation: Commencing from above, outside the diseased tissue, he dissected away the whole diseased tissue, excluding the hymen, the incision starting on the right side and from above. He came down upon the posterior commissure and upon the left side after the diseased tissue had been removed. He dissected the posterior vaginal and lateral wall for about one inch, and cut partly through the external perineal muscle so as to have a large vagina. He then sewed the vaginal mucous membrane to the healthy skin. The patient made a good recovery. C. F. Kivlin (*N. Y. Med. Jour.*, Jan. 20, 1912).

If operative measures are impossible, physiological rest of the parts, cleanliness, and treatment to relieve the pruritus (*q. v.*) are indicated.

PRURITUS VULVÆ.—Though but a symptom, vulvar pruritus causes suffering so intense in some cases as to have led to nervous breakdown, insanity, and even suicide.

Among the causes are discharges from the vagina and vulvar glands, various uterine disorders, especially fibromas, pregnancy, abortion, pediculi, erythema, eczema, herpes, and other cutaneous disorders, especially in corpulent women, diabetic and gouty subjects; irritation by fine hairs on the inner aspect of the labia majora; kraurosis vulvæ, and other atrophic changes attending senility, physiological or normal menopause; acidosis due to high living and alcoholism, gonorrhea, syphilis, intestinal worms, especially oxyuris, associated with anal pruritus; in infants, thrush, and, finally, nervous disorders in which the dread of vulvar pruritus brings it through what has been termed "pruriginous mnemodermia."

Treatment.—The modern treatment consists of eradication of the cause

while using palliatives. In all states traceable to deficient metabolic activity, especially when due to senility or the menopause—physiological or artificial—corpus luteum, thyroid gland, or pituitary gland, all in small doses, often prove effective.

In 2 cases of pruritus vulvæ associated with the menopause, the itching was with great promptness relieved by internal administration of an extract of corpora lutea of pregnant cows. W. T. Dannreuther (Jour. Amer. Med. Assoc., Jan. 31, 1914).

Toxemias of intestinal origin, shown by indicanuria, should be met by intestinal antiseptics and free purgation by salines. Abstention from shellfish and alcoholic beverages sometimes suffice in eczematous cases. In others it is kept up by acid fruits, spices, etc. Strawberries and green gooseberries are not infrequent causes. Decayed teeth may provoke vulvar pruritus, doubtless through pyorrhea. The nervous system should be quieted by valerian, with a dose of the bromides, and hot milk on retiring.

In pregnant women pruritus vulvæ is often sufficient as to entail loss of rest and sleep, and to induce pronounced nervous irritability. In some cases the cause is without doubt the presence of more or less well-marked discharge, but the writer has found sugar in the urine of all the pregnant women who have complained of discomfort and irritation of this part. He permits no ingestion of sugar or sweets, and prescribes for them Vichy water as a drink. A local application of hot water, with 10 Gm. (2½ drams) of chloral, is made four times a day, the parts being afterward treated with an ointment of ichthyol 10 Gm. (2½ drams) and benzoïn. A few days later a powder made up of zinc oxide, bismuth, and talc will be found useful. If there is

any leucorrhea a morning and evening douché containing 20 Gm. (5 drams) of sodium borate is prescribed. Rudaux (Brit. Med. Jour., Sept. 27, 1910).

[Carnot found that a tablespoonful of fresh yeast in a quart (liter) of water applied as a lotion to the vulva and used as a vaginal injection caused disappearance of the sugar from the inflamed parts, arresting the pruritus.—Ed.]

When medical treatment of pruritus vulvæ fails, nerve resection gives good results. In a woman of 34 the author resected on the right side the superior perineal branch of the pudic nerve for a distance of 3 cm., back of the transverse muscle of the perineum and on the left, incising along the ascending ramus of the ischium, the lower branch of the perineal nerve for 3 or 4 cm. in front of the transverse muscle. Pain and discomfort disappeared the same day and never returned. Mauclore (Ann. de gynec. et d'obstet., Sept., 1917).

Dechaux found efficient a pad of absorbent cotton dipped in water as hot as the hand can stand, containing 3 or 4 tablespoonfuls of good vinegar to the quart, then dusting with talcum powder. In other cases, jets of warm or cold water act better.

The X-rays are useful but cause much depilation. Radium is best. The constant current has been curative.

Operative measures include the application of caustics or the cautery to an erosion of the cervix; curettage, if endometritis exists; division, under anesthesia, of the vaginal constrictors, with the introduction of Sims's glass tube or a thick gauze plug; removal of Bartholin's glands. Evans (Clin. Jour., June 26, 1912).

Among the lotions proved useful are: camphorated brandy, chloroform water, potassium bromide (25 Gm.—6¼ drams—to the liter—quart), morphine, ichthyol (20 Gm.—5 drams—to the liter of water), and naphthol (15 or 20 Gm.—4 or 5 drams—to the

liter of water). **Psychic treatment** is an adjuvant. Dechaux (*Revue de gynéc., et de chir.*, June, 1914).

Where leucoplakia or kraurosis exists, **excision of the pruritic tissues** is curative and wards off cancer. The X-rays have been used with benefit.

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VAGINOPERINEAL INJURIES. See PREGNANCY AND PARTURITION, DISORDERS OF.

VAGOTONIA AND SYMPATHETICOTONIA.—The vegetative nervous system, which includes all nerve fibers supplied to organs having smooth muscles and glands, and to the heart, is divided into a *sympathetic* system proper and an *autonomic* system. These 2 systems are antagonistic functionally, yet both furnish fibers to each organ. The most important autonomic nerve is the vagus, fibers of which go to the heart, stomach, bronchi, esophagus, intestine, and pancreas.

Vagotonia has been conceived of by Eppinger and Iles to denote a morbid hyperexcitability of the autonomic or "extended vagus" side of the vegetative system. The diagnosis of vagotonia can always be established by a study of the action of the various drugs which act on the sympathetic or autonomic system.

Symptoms.—These include accommodation spasm, widening of the palpebral fissure, mild convergence spasm, and epiphora. Salivation is exaggerated, and sweating is common. The feet often become cyanotic in cold weather. Dermatographia and pigmentation are noted. Bradycardia, cardiac irregularity, and precordial pains are also mentioned. Ashner's phenomenon, a bradycardia caused by pressure upon the eyeball, likewise occurs in vagotonia. Asthma may exemplify periodic vagus irritation. Anaphylaxis seems to occur especially in vagotonics. This applies also to eructations, hyperacidity, sensations of fullness, pressure, acute distension, pylorospasm, vomiting, etc. The intestinal symptoms are spastic constipation, periodic diarrhea,

mucous colitis, and rectal tenesmus. Neurotic genital symptoms may also be noted.

Pathology.—The internal secretions are believed to be at fault. Vagotonia occurs in the young and constitutionally inferior, and may be related to status lymphaticus.

Treatment.—Atropine improves the spastic states of vagotonia, but must be given perseveringly in ascending and descending doses (Sublinski). **Arsenical waters** were also found useful. Atropine is very helpful in dysmenorrhea of vagotonic origin (Spitzig). In some it produces flushing, tachycardia and cerebral excitement, as in a child observed by Boehm, but adrenalin proved helpful, temporarily. As a matter of fact, vagotonia rests merely on theoretical grounds. S.

VALERIAN.—Valerian is the rhizome and rootlet of *Valeriana officinalis* (nat. ord., *Valerianaceæ*). It contains oil of valerian, composed of esters of valeric (valerianic) acid, chiefly borneol valerate.

PREPARATIONS AND DOSES.—*Valeriana*, U. S. P. (valerian). Dose, 30 grains (2 Gm.).

Tinctura valeriana, U. S. P. (tincture of valerian), a 20 per cent. preparation. Dose, 1 to 2 fluidrams (4 to 8 c.c.).

Tinctura valeriana ammoniata, U. S. P. (ammoniated tincture of valerian), made from powdered valerian, 20 parts, and aromatic spirit of ammonia, enough to make 100 parts. Dose, 15 to 60 minims (1 to 4 c.c.).

Ammonii valeris, U. S. P. (ammonium valerate or valerianate), occurring in colorless plates, very soluble in water or alcohol. Dose, 7½ grains (0.5 Gm.).

Zinci valeris, U. S. P. (zinc valerate or valerianate), occurring in white scales, soluble in 58 parts of water and in 35 of alcohol. Dose, 2 grains (0.12 Gm.).

Among related unofficial compounds are: bromural (monobromisovalerylurea), 5 to 10 grains (0.3 to 0.6 Gm.), and validol (methyl valerate), 10 to 15 drops.

PHYSIOLOGICAL ACTION.—Valerian is held by many to exert a pronounced stimulating effect on those cerebral centers which exert psychic control, thus having the power to allay nervousness.

Valeric acid and the non-volatile valerates exert little of the effect of the fluid

valerian preparations, and the effect of the salts is practically limited to that of the combined metals or alkaloids (e.g., quinine). The volatile valerates, such as borneol valerate, seem to act largely like valerian itself.

THERAPEUTICS.—Valerian is by many held to be useful for the relief of various forms of functional nervous disturbance associated with overexcitability or exhaustion of nervous tissues. It is, therefore, administered in general nervousness, nervous insomnia; insomnia after acute infections, nervous headache or tinnitus aurium; gastralgia, neurasthenia, hysteria, nervous tachycardia, the cardiac palpitation of smokers and alcoholics; vascular, gastric, intestinal, and sexual neuroses; congestive dysmenorrhea, the vomiting of pregnancy, and climacteric disturbances. Aromatic elixir and the oils of gaultheria and peppermint are among the best agents for disguising the unpleasant taste of valerian. The ammoniated tincture of valerian is a useful preparation where combined stimulating and carminative effects are desired. S.

VALVULAR DISEASES OF THE HEART. See ENDOCARDIUM AND HEART, DISEASES OF.

VARICELLA.—**DEFINITION.**—A mild, contagious, eruptive disease, also known as chicken-pox, occurring chiefly during childhood and youth.

SYMPTOMS.—The incubation varies from 10 to 15 days. Although the eruption often appears first, there is generally slight chilliness, a temperature rise of 2° or 3° F. (1.1° or 1.8° C.), restlessness and peevishness, slight pains in the head and back, and general lassitude. In 24 or 36 hours a strictly vesicular eruption appears, more upon the trunk of the body, but some on the face and neck. The fever continues, and new vesicles appear, especially on the face and scalp, for 3 days, after which the indisposition quickly disappears. The vesicles have no hard or indurated base, are mostly ovoid in shape, and filled with a slightly turbid serum, which gives them a pearly hue.

They never become confluent. Each vesicle begins to shrivel or dry up in 24

or 36 hours after it appears, and form a thin, light-brown scab. Consequently the first vesicles are often seen dry when the later ones are just appearing. In 5 or 6 days the eruption has all become dry and the scabs fall off, generally leaving no indentations or permanent scars. In a small percentage of the cases, however, a very few distinctly pitted and permanent scars have been left these probably resulting from scratching or otherwise causing inflammation to extend deeper into the cutis vera. The duration of the disease from the first indications of fever to complete convalescence is generally from 7 to 10 days. Very rarely the vesicles appear in the mouth and fauces, and cause much annoyance to the child in eating.

In some cases the appearance of vesicles on the skin is preceded a few hours by small, red spots. Rarely the eruption is hemorrhagic. Cases have also been recorded in tuberculous, anemic, and otherwise unhealthy children, and leaving gangrenous—*varicella gangrenosa*—phagedenic, or troublesome sores. Nephritis and paralysis have also been noted. In a few instances focal lesions of the central nervous system (encephalomyelitis) have been observed. Varicella occurring in previously healthy children, however, rarely is followed by any troublesome complication.

DIAGNOSIS.—The sudden development of the pearl-colored vesicles, the trifling general symptoms, the early resolution of the eruption, render the diagnosis quite easy. From *rubeola* varicella is distinguished by the absence of cough and catarrhal symptoms and the appearance of the eruption on the second instead of the fourth day. From *scarlatina* it is distinguished by the mildness of the febrile symptoms and the absence of intense redness and soreness in the fauces; and from both it and *rubeola* by the eruption appearing in plain, scattered vesicles containing fluid instead of mere red points or exanthems. From *variola* it is differentiated by the absence of 3 full days of active fever and severe pain in the back and head before the eruption appears. The latter presents at once an oval vesicle without any hard, elevated base as in *variola*; and as it progresses it begins to

shriveled, then dries up in two days, and has disappeared before a variolous papule would have completed its development into a pustule.

ETIOLOGY.—Though very contagious, there is no known cause of varicella. It prevails chiefly among children, and, in epidemic periods, only seldom attacking persons during adult life.

PROGNOSIS.—Uncomplicated varicella rarely, if ever, terminates fatally.

TREATMENT.—Rest, in clean, well-ventilated rooms, at a comfortable temperature, with a **plain, digestible food**, and strict personal cleanliness, is all that is required in a very large majority of cases of varicella. If a case is met with during the eruptive stage with scanty and high-colored urine and inactive bowels, a solution of **bitartrate of potassium** in cold water and rendered palatable by the addition of sugar, may be given in doses suited to the age of the patient until the kidneys act more freely and the bowels are moved.

If the vesicles appear so numerous on the face as to cause much heat or discomfort, they may be kept moist with an equal mixture of **glycerin and rose-water**. D.

VARICOCELE. See PENIS AND TESTICLES, DISEASES AND INJURIES OF.

VARICOSE VEINS AND ULCERS. See VASCULAR SYSTEM.

VARIOLA (SMALLPOX).—DEFINITION.—An acute, infectious and highly contagious disease, characterized by severe constitutional symptoms and the appearance on about the fourth day of a multilocular, macular eruption, which subsequently changes to papules, vesicles and pustules.

SYMPTOMS.—The period of incubation is from one to three weeks, usually about two weeks. The prodromal symptoms, lasting three or four days, are high temperature, rapid pulse, malaise, headache, severe backache, vomiting, chill, and sometimes

delirium or convulsions. It is at this stage of the disease that young infants frequently succumb. At this time a scarlatinal rash may be present, usually on the abdomen, arms and legs, and at the same time small red papules on the hard and soft palate and other parts of the mouth. The presence of this scarlatinal rash and papular eruption in conjunction with the constitutional symptoms is very diagnostic of smallpox before the appearance of the true eruption.

After four days of the foregoing symptoms the typical macular rash makes its appearance, which rapidly becomes papular, presenting a shot-like feel to the finger. This rash usually appears first on the forehead, from which it spreads rapidly over the entire body. At the time of its appearance the temperature will fall several degrees and the constitutional symptoms quickly subside. Twenty-four hours after the appearance of the papular eruption a small vesicle will be noticed on the summit of each papule, which rapidly enlarges, and is filled with a clear serum. Gradually a central depression or umbilication grows on each vesicle, and the vesicle is converted into a pustule, the contained fluid having a yellowish color. At this time, which is usually about the eighth day of the eruption—at which time it is distinctly pustular—secondary fever develops. The pustules are present for a number of days, and then slowly begin to dry with the formation of a brown scab. Following the falling off of this scab, the characteristic pitting will be noticed.

Albuminuria is present in most cases. Leucocytosis is the rule in this disease.

Special Form.—A form which has been named **confluent smallpox** is occasionally met with, and is so called because of the tendency of the vesicles to coalesce. This form is accompanied by considerable edema and infiltration in the pustular stage, resulting in such extreme disfigurement of the face that the patient is scarcely recognizable. In addition, this form of the disease is accompanied by a never-to-be-forgotten odor.

Another form called **varioid** (described in the next article) is a type of the disease that has been modified by vaccination.

DIAGNOSIS.—The diagnosis of smallpox before the appearance of the rash may usually be made with a fair degree of accuracy, especially when, in addition to the severe constitutional symptoms mentioned, the scarlatinal rash and the papular eruption in the mouth are present. After the skin eruption appears, the diagnosis is rarely difficult to make, the only disease with which one would be likely to confust it being chicken-pox.

During the invasion stage and before the appearance of the prodromal rashes the diagnosis, according to A. E. Thomas as modified by H. W. Hill (Lancet-Clinic, Jan. 1, 1912), must be made from the following diseases:—

Scarlatina.—With rash absent or "missed." Condition of tongue, cervical lymph-glands, tonsils, nose discharges, injection of soft palate (enanthem), circum-oral pallor, history of vomiting and sore throat. Backache, absent or slight.

Measles.—Coryza, photophobia, lachrymation, Koplik's spots, backache absent or slight.

Typhoid Fever.—Although this has not an acute onset; many cases when smallpox is rife are reported as smallpox. Attention should be paid to (a) gradual rise of temperature at onset; "step ascent" on chart;

(b) early epistaxis or deafness, not common; (c) Widal reaction; (d) tympanites; (e) condition of tongue; spleen, stools.

Influenza.—Here the diagnosis may be impossible until the time interval for the appearance of the rash has passed. The muscular soreness and prostration are both generally much more exalted in influenza than in smallpox. The history of exposure and the presence of an epidemic are of special importance here. The bacillus may sometimes be isolated from the sputum.

Meningitis.—The history, with the presence of a possible cause, e.g., suppuration of the middle ear or tuberculous focus in a lung, is important. The subsequent course, with the attending palsies, generally soon clears up the issue. Backache is uncommon.

Cerebrospinal Meningitis.—Retraction of the head; rigidity of the neck muscles; Kernig's sign; possible presence of the bacillus in the nasal discharge or in the fluid obtained by lumbar puncture.

ETIOLOGY.—In 1892 Guarnieri described a parasitic protozoa called *Cytoryctes variolæ*, which is now believed by some to be the specific micro-organism of smallpox, but the question is far from settled.

The cytoryctes of Guarnieri, while specific for smallpox, is not an organism, but a reaction product of the cell, and can be demonstrated at will in infant lymph. The cytoryctes may sometimes be found to contain a minute, coccoid, blue stained (Giemsa) corpuscle in groups. These may or may not be a form of the actual microbic exciter, but at any rate is commonly associated with the supposed cause of the disease, which does not stain with Giemsa, and which passes through a Berkfeld filter.

The bodies which the writer has been studying for a number of years are in reality the causative agent of variola and vaccine. They are very small, round, sharply defined, coccus-like objects, which divide directly. On many of these bodies one can see

a very delicate, filamentous process. Frequently the bodies are found in pairs, which are united by a filament; this appearance is even more striking with dark illumination. The two bodies seem to dance about, approaching and receding from one another. As von Prowacek has shown, this is Brownian movement. E. Paschen (Deut. med. Woch., Oct. 30, 1913).

Smallpox is the most highly contagious of all infectious diseases and spreads through every known medium of communication. The germ will live for years if kept from light and moisture. All ages are susceptible, children slightly more so than adults, but the degree of susceptibility varies according to the vital resistance of the individual rather than the severity of the infection.

PROPHYLAXIS.—The only prophylactic measure of any value is **vaccination** (*q. v.*); the disease may undoubtedly be prevented by this measure. Thus, during 20 years in Prague, each 10,000 vaccinated persons yielded 27 cases and 1 death, while 10,000 unvaccinated persons yielded 830 cases and 247 deaths.

TREATMENT.—Given a case of smallpox during the stage of invasion, the treatment would be largely symptomatic. Later frequent bathing will be much appreciated by the patient; an ice-bag to the head and hot-water bottle to the feet may be used to reduce the temperature; the bromides will be found of considerable benefit in view of the extreme discomfort that accompanies this disease, and a diet that is nutritious and easy of digestion should be employed. One of the causes of the greatest suffering is the intense itching that is present, for which cold applications

or various inunctions, especially those containing phenic acid, may be used with considerable benefit. **Stimulation** may be necessary in an emergency, but should not be used as a routine treatment. Sudden collapse may at any time demand active stimulation, and for this purpose alcohol may be employed.

Dry plaster of Paris is the best application for diminishing the supuration and mitigating the subsequent pitting, as well as for allaying the intense itching and overcoming the loathsome odor of the disease. Its good effects are most noticeable in severe cases of confluent smallpox, which are prone to terminate in deep cicatrices and actual deformity of the face. I. Zdanovitch (Semaine méd., July 15, 1908).

Ten grains (0.65 Gm.) of **hydrargyrum cum creta**, 3 times a day by mouth, continued for 6 days, produces no symptoms of poisoning in smallpox (with natives of India). The drug appears to have a marked action in modifying and reducing the severity of the disease. Nesfield (Indian Med. Gaz., Oct., 1908).

The writer has treated 85 smallpox patients with a mixture of 10 parts of iodine and 90 of glycerin, to shorten the pustular stage. The preparation was painted over the pustules two or three times a day. The results were the drying of the lesions, absorption of the toxin, arrest of tissue destruction, and prevention of subsequent pock-marks. All the cases recovered. Their average stay in the hospital was only 12 days. C. S. Rockhill (Jour. Amer. Med. Assoc., Jan. 27, 1912).

The local application of **aluminum acetate in alcohol** reduced the pain and itching so much that the patients clamored for it. The writer used 50 parts of the aluminum acetate to 1000 parts of alcohol rectified; cotton dipped in this was laid over the face and covered with oiled

silk. The chest, abdomen and back were also dressed with the same mixture, alternately during three hours. Pitting seemed to be materially checked. Traeger (*Therap. der Gegenwart*, May, 1915).

In 64 cases of smallpox the writer obtained a mortality of only 12.5 per cent., compared with 21 per cent. in 134 cases treated by former methods, by using a 10 per cent. solution of **spirit of camphor** in 90 per cent. alcohol as a local application several times daily, followed by painting with a mixture of **iodine**, 1 part, and **glycerin**, 2 parts. Warm baths with **lysol** solution were given daily besides, neutralizing the fetid odor of the disease. T. Taboada (*Cronica Medica*, Mar., 1916).

A form of treatment by the use of **light**, which is filtered through **red glass**, has been mentioned from time to time to prevent suppuration, but with very variable results.

Suppuration in the pustules of smallpox will never be so intense if the patients are treated with **red light**. It is therefore customary in many hospitals of the Far East to place smallpox patients in wards with windows of red glass. The writer praises this treatment, but mentions as serious drawback the difficulty of ventilation when no artificial system has been installed. Dreyer (*Münch. med. Woch.*, Aug. 2, 1910).

The strictest isolation and quarantine should be practised from the very beginning; a **bedpan** should be kept under the bed containing a solution of equal parts of **chloride of lime** and **strong vinegar**. To prevent the infection of outsiders by the physician, a dram (4 Gm.) each of **chlorate of potash** and **hydrochloric acid** should be mixed in an adjoining room at the time of the physician's arrival, in which room he should prepare himself to leave the house by

washing his hands and face in a weak **bichloride solution** and thoroughly brushing his clothes, if a gown and cap is not provided.

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VARIOLOID AND VACCINATION.—Although varioloid is but a mild form of variola, treated above, which may occur in individuals who, though unvaccinated, may be endowed with insusceptibility to the latter disease, it is also met occasionally in subjects who have been vaccinated. Hence its presence in this article.

VARIOLOID.—This is but a mild form of smallpox (described above). While the initial general symptoms are virtually the same, an erythematous rash usually precedes the typical eruption. The latter is quite scanty, appearing both on the face and trunk, and proceeds only, as a rule, to the vesicle stage. The vesicles may, however, be found in groups here and there, differing in this from smallpox. They usually appear about the end of the second day and continue until desiccation begins—about the sixth day. What fever there is usually ceases on the appearance of the eruption, and does not recur. Complications worthy of the name are practically never witnessed. The treatment is the same as that for smallpox.

VACCINATION.—This term is applied to a procedure through which, by inoculating human subjects with lymph from the vesicles of heifers or of human subjects suffering from cowpox (*vaccinia*) they are rendered more or less immune to smallpox.

[I say "heifers" here, instead of "cows" because a personal study of the subject at the Institut Vaccinogène of Brussels, Belgium, emphasized the importance of employing only heifers *not older than seven months* to obtain the lymph, if complications, local and general, from this source are to be avoided. Humanized lymph is no longer used, owing to the danger of transmitting disease, syphilis in particular. S.]

TECHNIQUE.—That employed by the War Department, which has been emi-

nently successful, is described by Dr. E. C. Cody, as follows, the vaccine used being that available to the profession at large, *i.e.*, the lymph furnished by the large manufacturers of the country:—

The area is cleansed with green soap, then alcohol; dried with cotton or gauze; abrasions made by scraping or scratching on the selected area, three being made, 1 inch apart. Instrument, ivory point or sterile scalpel. Dressing, sterile gauze, preferably, sometimes vaccine shield. Dressing changed as often as necessary to keep it clean and in good condition; if the vaccination is successful the second dressing is always sterile gauze. If primary vaccination fails, the process is repeated in a reasonable time, and is again repeated if the second attempt fails.

The U. S. Public Health Department holds that the best method is the simplest; hence, it uses scarification. Vaccination shields are avoided and aseptic bandages used. The arm having been dressed after the operation, the patient returns in 7 days, or earlier, if constitutional or severe local symptoms appear. The dressing is removed in successful cases revealing "a section of a pearl on a rose leaf." A bland ointment with sterile dressing is then applied, to protect the lesion until it is dry. If the vesicle has not matured and a mere scratch remains, revaccination a week or two later at the site of the first attempt revives the latter, causing it to run a short course synchronously with the second inoculation.

The most commonly employed method is to cleanse the skin—of the left arm about the deltoid preferably, and not the leg, which is more readily infected—with alcohol and to express the contents of the capillary tube on the cleansed area. The latter is then scratched with a sterilized needle *through the vaccine*, but not sufficiently deep to draw blood. The side of the needle is then placed over the scratches and the vaccine fluid rubbed in. The slight wound is then dressed aseptically.

According to many observers, and the New York State Commissioner of Health, the best possible cover for the little wound is the dried vaccine matter and clean unbroken scab or skin with which

nature covers the vaccinated spot. Sometimes a shield is put over it at first, but it had better be left off after a day or two. If it is worn it should be removed every day and the skin washed gently in water that has been boiled, and with a clean towel. When replaced the shield, also carefully cleansed, should not interfere with the circulation.

PREVENTION OF INFECTION.—

When soiled arms, such as those of immigrants, laborers, coolies, etc., are to be vaccinated, the danger of infection is prevented by the use of iodine, suggested by Major E. E. Waters, of the Indian Medical Service. The arm is painted with tincture of iodine, and at the same time the vaccinator, as he holds the arm, paints his left thumb-nail. The lancet blade is dipped in the tincture and allowed to dry. A sufficient quantity of lymph is extracted from the tube with the now sterile knife and placed either directly on the iodined arm or on the left thumb-nail; vaccination is then performed through the iodined skin and no dressing is applied.

Isadore Dyer holds that the vaccination injury should stop at the vesicle, that the pustule is only a sign of local infection, and hence should be prevented. Therefore, he advises **breaking the vesicle** and treating the vesicular lesion antiseptically, and suppuration will thus be prevented. Such a method prevents glandular enlargements, erythemas, and other eruptions. Albert and Holden found that the best antiseptic measure after opening the vesicle was to apply tincture of iodine to it as soon as possible after the latter has formed, and repeating the application 2 or 3 days later. By this method they succeeded in either preventing pustule formation or so limiting it that the several pustules which formed did not coalesce. As a result, the vesicles would soon dry up and form a small, dry scab. In not one of 116 cases so treated was there secondary infection with pus-producing bacteria, whereas in those not so treated about 30 per cent. were secondarily infected.

Acupuncture Method.—This method, introduced by H. W. Hill (1916), aims to do away with the older methods, all of which facilitate infection of the wound.

The arm is washed with soap and water, then with alcohol, and finally with ether. A small drop of vaccine is deposited on the clean surface. The vaccinator's hand is closed on the arm from behind, so as to draw the skin tight in front, and a carefully aseptized sewing-needle point, held slantingly nearly parallel with the skin, is pressed against the skin through the drop of vaccine. Then it is that $\frac{1}{1000}$ of an inch of the point sticks through the upper layer of the skin, carrying the vaccine with it. The needle is instantly withdrawn and another puncture exactly like the first is made close beside it, until six punctures are made in the space of $\frac{1}{4}$ of a square inch or less. The whole process of puncture takes perhaps fifteen seconds. At once, with a bit of sterile gauze, the surface vaccine is removed, and the sleeve drawn down.

SYMPTOMS.—After vaccination no appreciable effect is produced until the end of the fourth day. Then, at the point of introduction, will appear a small, hard, elevated papule with a minute vesicle on its apex, very closely resembling the individual papules of variola. The papule continues to enlarge in all directions for 4 days, the vesicle becoming first flattened, then indented in its center, and filled with transparent lymph. During the fifth day inflammation commences, indicated by an areola of redness, swelling, and a slightly turbid appearance of the lymph in the vesicle. The swelling and redness around the pustule continue to increase for 3 or 4 days, accompanied by slight symptoms of general fever, when a dark-brown spot appears in the center of the pustule now fully distended with purulent fluid. From this time all feelings of general fever disappear, the areola of redness and swelling diminishes, and the dry, brown spot increases until the pustule has become replaced by a thick, brown scab, under which cicatrization takes place and the scab falls off, leaving an indented or pitted cicatrix, or scar.

The process of desiccation usually occupies from 7 to 9 days, making the whole time from the introduction of the virus to the complete cicatrization of the pustule about 3 weeks. As a rule, in vaccination, papules appear only at the points

where the virus has been introduced; but in a very small percentage of cases a few papules have appeared on other parts of the surface.

REVACCINATION.—Although the protection afforded by vaccination has been known to continue indefinitely in the majority of cases, the period of absolute immunity lasts, as a rule, but 10 or 12 years, the minority being mainly composed of individuals in whom it lasts but 7 or 8 years. Thorough protection can only be expected, therefore, by renewing vaccination every 7 years, and when an epidemic prevails. Repeated vaccinations failing under these conditions, tends to indicate that the rebellious subject is still protected by his earlier vaccination. Even should infection occur in such a person the disease—though transmissible as smallpox to an unvaccinated subject—would prove relatively benign in practically every instance, constituting the syndrome described above: Varioloid.

Efficacy of Vaccination.—As may readily be ascertained in any smallpox hospital, recently vaccinated persons, including children, can live in such an institution, wait on the patients therein, breathe its contagium-laden air, and totally escape the disease. As recalled by Gay recently (*Boston Medical and Surgical Journal*, April 6, 1916), smallpox caused, before the discovery of vaccination by Dr. William Jenner, a tenth of the deaths in ordinary times, one-half in epidemics, and destroyed, maimed, or disfigured one-fourth of mankind. The evidence that vaccination practically prevents smallpox at the present time is overwhelming. Countries that are most efficiently vaccinated suffer least from the scourge. To give but a few examples, Germany, where vaccination is obligatory, has been free from the disease for more than 40 years, while the adjacent nations are never free. Systematic vaccination by the surgeons of the United States army in 6 provinces of the Philippines, having an approximate population of one million, reduced the annual smallpox mortality from 6,000 to nothing. During the succeeding 5 years there was not a death from this disease in this region of a vaccinated person. In 1885, smallpox broke out in Montreal; the

upper classes protected themselves by vaccination and escaped; the ignorant classes refused, and 3000 perished. If any event in human affairs has been demonstrated beyond a reasonable doubt, it is the great benefit to be derived from timely, efficient, skillful vaccination against small-pox. S.

VASCULAR SYSTEM, DISORDERS OF.—Several of the more important disorders of this class, arteriosclerosis, aneurism, angioma, angioneurotic edema, etc., having already been considered, this section will be devoted to conditions which, though not as frequently encountered, occupy a prominent position in nosology.

RAYNAUD'S DISEASE.—This malady, also termed in its advanced stage **symmetrical gangrene** (see also fourth volume, page 796), is the result of spasm of the arterioles, especially those of the extremities, which, by impeding the arterial circulation in the latter, provokes in them pallor, coldness, tingling, pain, and cyanosis; and in some cases, when the vascular obstruction is complete, gangrene.

Symptoms.—In the early stage of the disease, the only symptoms are such as would suggest slight freezing of the fingers or toes, the tip of the nose, the margins of the ears, etc., with their usual attendants, pallor and numbness. After a few hours, perhaps, or on returning to warmer quarters, there is slight tingling and hyperemia, soon followed by the restoration of normal conditions. Later, similar phenomena recur, but this time they may be more marked, cyanosis, burning pain, followed by pulsative congestion suggesting the presence of severe chilblains—which local disorder is closely simulated.

Such mild attacks may recur frequently, or, perhaps, only once or twice, but ultimately there occurs one in which, after exposure to cold, the blueness or cyanosis of the fingers persists, and their projecting portions, the pads or knuckles, or, perhaps, the tip of the nose or margins of the ears swell and become bluish black, and finally slough off as necrotic tissue, leaving scars. Or, after the preliminary pallor, coldness, etc., severe pain, extending perhaps to the hand, occurs, and cyanosis and gangrene of one or more fingers or toes follows, the first phalanges in marked cases being lost. Similar attacks may follow at weeks' or months' intervals, but in the more severe cases a hand or foot, or both upper or lower extremities, require amputation, owing to appearance, finally, of symmetrical gangrene. In such cases the suffering may be acute.

Hemoglobinuria may accompany the attacks or supplant them, and is more common in children than in adults. Urates are often found in the urine; sugar occasionally. The hemoglobinuria is doubtless due to involvement of the renal vascular supply in the morbid process. The latter may also affect the vessels of any organ, even the cerebrospinal system, and thus cause convulsions, melancholia, hemiplegia, aphasia, and finally death from exhaustion. In some patients the disease ceases spontaneously.

Etiology and Pathogenesis.—Raynaud's disease is uncommon, but seems to be more frequent among Hebrews than among other races, the largest proportion occurring in females, and between the tenth and fortieth year, though the very young

or old are not exempt. A neuropathic heredity or the presence of neurasthenia, epilepsy, gout, migraine, mental disorders, hysteria, or other neuroses seem to predispose to it; also arteriosclerosis, sexual excesses, syphilis, malaria, various infections, lead and benzine poisoning. As to the immediate causes, cold weather, frequently recurring chilblains, frequent immersion of the hands in cold or hot water, as in certain occupations, and menstruation have been incriminated. Several acute cases, in which fright and exposure to cold and wet concurred, were observed after the recent earthquake in the Abruzzi, Italy.

Raynaud, who, in 1862, gave the disease its true place in nosology, maintained that it was a neurosis of central origin, what arterial or peripheral nervous lesions he found being evidently secondary, gangrene occurring without such lesions to account for it. That contraction of the peripheral arteries accounts for the local syncope has been shown by the reduced caliber of the radial, retinal, and other vessels, but the nature of the process has remained obscure.

From my viewpoint, the arterial spasms are due to two concomitant factors: 1. Abnormal excitability of the cutaneous fibers of epicritic and protopathic sensibility—the former of which are not stimulated by cold above 26° C. (78.8° F.) and the latter by heat below 37° C. (98.6° F.). 2. Abnormal excitability of the spinal cells, probably sympathetic, which govern the vasoconstrictor nerves of the cutaneous arterioles. When the cutaneous sensory terminals mentioned are exposed to temperatures, cold or heat, capable of exciting them, they stimulate with abnormal violence the oversensitive spinal cells and reflexly produce a peripheral vasomotor spasm to which the disease is due. Personal experiments have

shown that when the skin of exposed areas was covered with a substance, flexible collodion, for instance, which protected its sensory terminals from contact with air at a temperature capable under ordinary circumstances of provoking a spasm, the latter failed to occur.

Treatment.—Any underlying cause of the disease (see under Etiology) should, if possible, be eliminated. In practically all cases removal to a warm and equable climate affords marked relief, and sometimes insures a cure. Hot air has been recommended by Bensaude; radiant heat baths, or the more convenient warm poultice and warm bath tend to arrest the attacks of local syncope where cold is the spasmogenic agent. Amyl nitrite inhalations occasionally do so. To prevent their return when the patient is obliged to be out in cold weather I have used as adhesive covering flexible collodion, which does not crack, with excellent results, in addition, of course, to the usual warm gloves or stockings worn by the patient as a rule. The collodion is painted over the fingers and toes, and thus coating the cutaneous sensory terminals for cold. Beck found a 10 per cent. solution of ichthyol to afford marked relief.

To oppose the tendency to angio-spasm thyroid gland has been used by Battus and Osborne, but sodium iodide in large doses is at least as efficient and need not be closely watched; it may be given with sodium bromide to reduce the hypersensitiveness of the spinal centers. Nitroglycerin has been recommended, but it fails in most cases; the spirit of nitrous ether, 30 drops taken when an attack is starting, sometimes arrests it in patients given the iodides and bromides, as stated above. Elec-

tricity, massage, or the Tourniquet were recommended by Cushing, but such measures are often painful and not always efficient. The treatment indicated when gangrene occurs has already been reviewed in the fourth volume, page 799.

ERYTHROMELALGIA.—This disease, also known as **red neuralgia** and **Weir Mitchell's disease**, is characterized by neuralgic pain, tenderness and congestion of the feet, and sometimes of the hands when these are dependent, and after severe exertion or use of these extremities.

Symptoms.—Tenderness of the feet, especially of the soles or palms, followed by actual burning pain mark the onset of most cases. The affected extremity will then be found to be the seat of a congestion, with a local rise of temperature, and more or less covered with irregular patches of redness, the arteries pulsating abnormally. After a time, cyanosis may appear, the affected extremities becoming either purplish red or pallid with bluish hue, and cold. These symptoms are aggravated by warmth (including warm weather), the dependent position and exercise, and eased by cold. The onset of the symptoms may be more or less sudden and paroxysmal, their gravity increasing up to a more or less marked acme, which is followed by an equally gradual recession to normal. There is no edema, and the local hyperemia, even if it proceeds to cyanosis, does not lead to gangrene. Paresthesia and hyperesthesia of the affected region are usual. Otherwise the health is normal, the disorder occurring only when the affected member is dependent, as in standing; the reflexes are, as a rule, exaggerated.

Etiology and Pathology.—The disease occurs somewhat more frequently in males than in females. Puberty, menopause and infectious diseases may act as predisposing causes. Cold and damp, frequent immersion of the extremities in cold water, excessive use of the limbs and traumatisms proved to be exciting factors in the relatively few cases reported, the disease being rare. Its pathology is still obscure, though believed by some to be much the same as that of Raynaud's disease, *i.e.*, a vasomotor neurosis. In some cases it seems to occur in association with disorders of the spinal cord and peripheral nerves.

This disorder is placed immediately after Raynaud's disease because, from my viewpoint it is to a certain extent its antithesis as regards the influence of the nervous system on the phenomena observed. Briefly, we are dealing here with a primary vasodilation instead of a primary vasoconstriction. Moreover, the teachings of modern physiology tend to indicate that it is the vasomotor system and not the sympathetic (autonomic) which underlies the morbid process through excessive vasodilator impulses. As is well known, destruction of the vasomotor center is followed by immediate dilatation of all the vessels of the body. But stimulation of certain afferent nerves produces similar effects reflexly. In erythromelalgia—only from my viewpoint of course—we are dealing with abnormal excitation of the peripheral terminals of such sensory nerves—epicritic or protopathic, as the case may be—in persons whose central vasomotor center is, as a result of conditions mentioned above, abnormally ready to respond to such vasodilator impulses, especially when their occupation is such as to increase the morbid process by constant exposure or irritation.

Treatment.—The essential feature of the treatment is to seek carefully

the cause and remove it. The prevailing treatment is rest with elevation of the limb from six to twelve weeks, daily massage to promote circulatory activity, cold douches or cold packs, and which prove grateful to the patient. Rubber bandages have been used to facilitate locomotion. Moleen has found adrenal gland useful, doubtless owing to its influence on the central vasomotor tone, which effect the faradic current also tends to increase. Resection of the motor nerves to the affected area has been performed, but in view of the fact that spontaneous cure occurs often when the cause of irritation is removed, such a radical measure is not warranted. From my viewpoint adrenal gland, strychnine, digitalis, or, better, digitalin in full doses are indicated to promote the contractile power of the arterial musculature and thus enable it to oppose, with greater efficiency, the vasodilator impulses. Painting vulnerable surfaces with flexible collodion is efficient to protect them against cold. Ichthyol painted on the congested areas when these persist favors their resolution.

ACROPARESTHESIA.—This disease is characterized by numbness, tingling, and pain in the fingers and hands, also occasionally in other regions, due in most instances to exposure to cold and damp, hard usage of the hands, etc., in a predisposed subject.

Symptoms.—The salient symptoms of the disease are tingling, "falling asleep," burning, itching of the hands and arms, occurring either at night, especially toward morning, or on using the hands, and increased by heat. If any discoloration occurs in the fingers—or toes, which occasion-

ally are also affected—they are paler than usual and cold, their temperature being reduced from $\frac{1}{2}^{\circ}$ to 2° C. (0.9° to 3.6° F.). Paresthesia is observed in some and anesthesia in others. Rarely the head, face, chest, back, and abdomen are involved. Numbness and stiffness of the hands are commonly observed. Friction, walking, or movement of the parts tend to reduce the discomfort. The attacks of acroparesthesia may last but a few minutes and recur at long intervals; in other cases they may last many hours and recur frequently, and even, though rarely, may persist continuously. Often they cease when their cause is eliminated; otherwise they become progressively worse.

Etiology and Pathology.—Of 200 cases studied by Lesem, 94.5 per cent. were in women, the majority being in those whose occupations tended to expose them to wet and cold, continuous hard use of the hands, as in tailoring, etc. The majority of patients were between the ages of 30 and 40 years. Menstrual, puerperal, circulatory, and gastrointestinal disorders appeared to be the chief predisposing causes. It has also, though rarely, followed traumatism.

Pathogenesis.—The pathology of the disease is admittedly unknown. It has been attributed to defective peripheral venous circulation with resulting serous infiltration of the nervous terminals; a vasomotor disturbance, etc. Oppenheim attributed it to extraordinary irritability of the vasomotor center as a result of which the arteries are contracted and the nutrition of the peripheral nerve endings perverted.

Oppenheim overlooks the fact that marked irritability of the vasomotor center would manifest itself by hyperemia of the surface, and not as in the present disease by constriction of the peripheral vessels as evidenced by the primary pallor, hypothermia, numbness, etc., of the affected areas. The sympathetic (autonomic) factor must be included to account for the phenomena observed, much as is the case in Raynaud's disease. It probably differs from the latter, however, in being brought about by abnormal irritation, through cold, wet, pressure, etc., of the cutaneous nerve endings of epicritic sensibility which, as separate sensory terminals, enable us to make the finer discriminations of touch and temperature. The spinal autonomic centers, themselves irritable through one of the systemic factors enumerated, would find in the peripheral irritation the factor necessary to incite and perpetuate the disease.

Treatment.—The main indication is to eliminate the external cause. This is often a difficult matter where a trade or other means of livelihood must be abandoned. Yet it is usually possible to cause the sufferers to modify the feature which is actually harmful to the affected members. Any pathological factor, whether circulatory, gastrointestinal, menstrual, puerperal, etc., must receive attention. On the whole, the measures indicated are the same as those recommended for Raynaud's disease.

VASOMOTOR ATAXIA.—This term, subsequently amplified to *autonomic ataxia*, was first applied by Solomon Solis-Cohen, in 1885, to an abnormal condition of the sympathetic (or autonomic) nervous system, through which, as a result of hereditary or of debilitating influences, it fails to carry on adequately its visceral and especially its cardiovascular functions. The circulatory (vasomotor) aberrations, provoked

under the incidence of various exciting causes and local detriments, may be constrictive, dilative, or mixed, or be local, diffuse, or general. Secretory and visceromotor disorders of various types may be produced similarly. The chief excitants are heat and cold, emotion (including worry and shock) and toxic agents of endogenous or ectogenous origin.

Symptoms.—The disorders built upon autonomic ataxia are often widespread, but their peripheral (circulatory and trophic) manifestations are those most readily observed. Cutaneous marbling, angioneurotic congestions and edemas, varices and even angiomas are the external expressions of similar conditions of the superficial or deeper internal structures. Not only the conjunctivæ, retinæ, nose, lips, mouth, tongue, pharynx, esophagus, cardia and pylorus, rectum, larynx, trachea, bronchi, but also the appendix, gall-duets, pancreatic ducts, ureters, uterus, and other abdominal organs, and even the brain, as shown by Hansell's studies of the ocular fundus, may be the seat of these vascular disturbances.

As a source of subjective phenomena—usually paroxysmal, recurrent, and painful—such hyperemias and ischemias cannot but be prolific. While the upper respiratory tract may contribute hay fever or asthma, or both, to the semeiology of the fundamental disturbance, the skin may offer urticaria, eczema, purpura, and falling of the hair; the gastrointestinal canal, indigestion, cyclic vomiting, colic, membranous enteritis, serous diarrhea, hepatic or appendicular colic (leading at times to unwarranted operations), hematemesis, and even gastric ulcer, etc.; the urin-

ary system, renal colic (but not calculus), glycosuria (from adrenal or pancreatic disturbance), polyuria, albuminuria, hematuria, etc.; the genital system, menstrual and other disorders; in the joints, rheumatism, angioneurotic swellings simulating, and gout. Arthritis deformans, genuine rheumatic disorders, and tuberculosis have an etiological rather than a symptomatic relationship with the condition. Paroxysmal disorders include also migraine, pseudoangina (pectoris and abdominalis) "palpitations," functional cardiac murmurs, tremors, muscular spasms, leg cramps, with epileptic seizures as an occasional surprise to emphasize the importance of the morbid process in point. All these varied phenomena, to which many could be added, may, owing to the differing incidence in excitants and local determinants, supplement, supplant, or complicate one another.

The objective phenomena are no less varied. Besides the obvious dilatations or constrictions of the superficial vessels, we may have massive congestion of the dependent parts, especially the hands, these being perhaps pink, red, blue, or leaden, mottled, with the finger-tips enlarged and the nails, perhaps, incurved, bicolored, tricolored, etc. The whole gamut of Graves's disease may become developed, even to the exophthalmos, the Stellwag and Graefe signs, and the enlarged thyroid. Certain cases present Raynaud's phenomena.

The usual low blood-pressure (*circa* 100 S. 80 D.) may, conversely, become high during spastic paroxysms. Moderate anemia, with hemolysis, is not uncommon, while in some cases persistent eosinophilia is the rule.

Recurrent blood-losses from any or all regions are not rare.

Diagnosis.—Not only the immediate collation of symptoms but the fundamental (constitutional) liability of the patient is to be recognized. Here family tendencies and history, as well as the patient's previous record, are important. The array of syndromes reviewed points to the underlying autonomic imbalance; but various tests facilitate its recognition. Blushing, easily evoked, finds its ruder counterpart in the readiness with which hot water or counterirritants provoke cutaneous hyperemia. The converse is likewise true—the ready production of pallor and cyanosis and even blackness of the nails by cold. The presence of vasomotor ataxia is emphasized, moreover, by the fact that plunging the cyanotic member in ice-cold water will not only produce hyperemia, but also cyanosis in the parallel non-immersed member. Dermographism, either ischemic, hyperemic or mixed factitious urticaria, local or general pilomotor reflexes, all point in the same direction. Excessive or peculiar (idiosyncratic) reactions to drugs, as quinine, epinephrin, thyroid preparations, pilocarpine, and atropine, either administered as tests or taken previously as medicines, give valuable clues as to the particular portions of the autonomic-sympathetic system or endocrine gland system, chiefly or exclusively affected.

Treatment.—Each case is a problem unto itself and requires individual management. It may symbolize Raynaud's disease, Graves's syndrome, erythromelalgia, hay fever, asthma, migraine, etc., and call for the measures indicated in these disorders

(*q. v.*). Apart from such, however, treatment addressed to the underlying abnormality—apathy or erethism—of the sympathetic or autonomic system is necessary.

Erethism betokens central irritability. Rest and avoidance of emotional excitants, correction of eye-strain and of anatomical maladjustments such as visceral ptoses, uterine displacements, etc., the prevention of autotoxis by regulated diet, gastric lavage, occasional purgation with calomel as main agent and lactic bacilli, hexamethylenamine, phenyl salicylate, etc., as intestinal antiseptics, are prominent among the measures calculated to allay this central erethism. As a corollary to these measures, the cardiovascular tone, enfeebled by aberrant stimuli, must be enhanced; in addition to hydrotherapeutic and mechanical measures to re-educate the vascular responses, adrenal, posterior pituitary and thymus preparations, digitalis, sparteine, strophanthus, cactus, quinine hydrobromide and ergotin exemplify the types of agent indicated, to which galvanization, faradization, and the static breeze are potent adjuvants. When persistent sweating betokens disorder of the sweat-glands, atropine outstrips all other agents.

Conversely, we may encounter high blood-pressure in such cases, the heart laboring to overcome the spastic constriction of the arterioles. Here, mechañotherapy, hydrotherapy, autocondensation, and high-frequency currents, the nitrite group erythrol tetranitrate, with amyl nitrite in emergencies are indicated, with the iodides and thyroid gland to relax the contracted peripheral arteries and sustain the effect, thus restoring the

circulatory equilibrium. Picrotoxin as a central stimulant may be useful in all cases, but especially in those (the most frequent) showing mixed phenomena.

TRAUMATIC NEUROSES.—

This collective term, which includes those of railway spine, concussion of the spine, concussion of the spinal cord, railway brain, is applied to various nervous disorders which may develop subsequent to, and as a result of, injuries, shock, concussion, fright or other factors capable of producing a violent structural disturbance of the nerve-centers, cerebral and spinal (including those of the ductless glands) and manifesting themselves in the form of vascular neuroses, of which traumatic neurasthenia, traumatic hysteria, traumatic epilepsy, and traumatic insanity and combinations of these disorders are the main expressions.

Pathogenesis.—The participation of the ductless glands in the underlying morbid processes modifies the older conceptions of the pathogenesis of traumatic neuroses

In 1903 ("Internal Secretions," p. 598 *et seq.*) I attributed to the posterior pituitary the rôle of a central sensorium (*sensorium commune*), which reacted to sensory impressions of external origin "traumatism, surgical procedures, an abnormal mental state such as attends fear, grief, or other emotions, etc." The morbid effect being defined as a "molecular jarring of the posterior pituitary body, harmless when slight, pathogenic when sufficiently intense, but fatal when a certain limit is reached." The influence of the same organ upon the body at large, but particularly upon the functions of the thyroid and adrenals, with which organs it formed what I termed the "adrenal system," was repeatedly emphasized throughout the same work, and in the third edition (1909, page 606) I established for the

first time the direct connection between the ductless glands and traumatic neuroses by the statement that "fright, trauma—the cause of acromegaly in 19 of 130 cases (Hinsdale)—provoke various diseases, exophthalmic goiter, acromegaly, railway spine, and concussion, for instance. . . ." In 1911 the brilliant researches of Cannon and La Paz, and subsequently those of Cannon himself, confirmed the influence of fright and other emotions on the adrenals, while Crile not only emphasized the rôle of the thyroid under similar conditions, but through his "anoci-association" (*q. v.*, page 122, this volume), introduced measures intended to control the pathogenic influence of traumatic stimuli upon the central nerve-cells.

It is through the sympathetic (or autonomic) system that the vascular supply of the ductless glands is co-ordinated, and one has but to study even cursorily a case of Graves's disease due to traumatic shock, for instance, to realize that there is a paretic dilation of the arterioles, not only in the thyroid, but also throughout the system at large. This applies, in my opinion, to all the various syndromes of traumatic origin witnessed.

Erichsen's view (1871), supported by Erb, that a sufficiently violent concussion caused molecular disturbance, has been abundantly sustained by the experiences of the present war, "cerebral and spinal concussion" and "physical trauma," with demonstrable cellular lesions, such as those depicted in this country by Crile, having been shown to prevail, even where no structural trauma occurred, and as a result of shell or mine explosions of great violence. "When the shell explodes near a sleeping person" writes Gaupp (*Beiträge z. klin. Chir.*, Apr., 1915) "it does not induce the nervous and mental disturbances otherwise observed. This throws light upon the importance of fright as a factor"—a graphic reminder of a fundamental principle of traumatic neuroses. Again, Mott (*Lancet*, Feb. 26, 1916) found that a large proportion of 156 cases of shell shock was in neurotics and that neurasthenia and hysterical phenomena predominated, some exhibiting amnesia, mutism, and even epilepsy—all features which, as we shall see below, are charac-

teristic of traumatic neuroses. From my viewpoint, with the ductless glands as features of the problem, the primary molecular jarring caused by fright—a psychic complex—manifests itself mainly upon the most sensitive of the cerebro-spinal cellular elements, the sympathetic (or autonomic) cell aggregates beginning with what I deem to be their main or upper nucleus located in the posterior pituitary body. Inasmuch as the thyroid and adrenals (and also all other *true* ductless glandular tissues) are innervated by the sympathetic, there occurs primarily, as a result of the emotional, *i. e.*, psychic excitement, the excessive outpouring of secretion demonstrated, as regards the adrenals, by Cannon, but followed by exhaustion of the organs varying in intensity with the violence of the pathogenic emotion. *It is this exhaustion of the ductless glands which provokes the various phenomena grouped collectively under the term traumatic neuroses, by causing, among other effects, atony of the arterioles* (the tone of which is sustained by the chromaffine system), *slowing of cellular metabolism through lowered oxidation, and defective catabolism of waste, and the resulting accumulation of toxic intermediate products in the blood.* The bearing of these morbid phenomena will appear under Symptomatology.

Symptomatology.—The symptoms of the various syndromes awakened by a traumatism, physical or mental, correspond clearly with those of diseases to which they have been assimilated. Thus *traumatic neurasthenia* differs in no way from the classic form (*q. v.*), but it is apt to be more serious and disabling; yet the seriousness of a case may readily, owing to the relative simplicity of symptomatology, be exaggerated by a claimant. Here the pathology is virtually that of shock with vasomotor (autonomic) paresis, low blood-pressure, and chromatolysis in severe cases from deficient oxidation. *Traumatic hysteria* tends likewise to prove serious, but in proportion as

the individual is predisposed to the disorder. It is usually due to fright and may thus fail to develop if the traumatism is received during sleep. In males it is usually associated with neurasthenia and may assume the type of a hypochondriacal psychasthenia. Railway accidents, owing to the sudden fright caused, not infrequently produce this form, which is proportionate with the amount of shock. The main result here is atony of the arterioles: irregular tissue oxidation sometimes spasmogenic through the presence of toxic catabolic wastes in the blood. *Traumatic epilepsy* may develop from head injuries, and the claim that the injured will suffer from this disease is usually made. In truth the proportion of instances in which it develops is extremely small—hardly once in two hundred head wounds, including some in which complete perforation of the brain had taken place. Malingering is occasionally resorted to in this connection. The malingerer is apt to overlook the fact that the thumb contracts inside the fingers and seldom stands pin-pricks, ammonia vapor, etc., with the equanimity that the profound unconsciousness of epilepsy permits.

In these cases the blood-pressure is high during convulsions which have for their purpose the destruction of toxic wastes; but low between them—which indicates slowed metabolism and defective hydrolysis of wastes.

Traumatic insanity is still more rare. In the European war, notwithstanding the many conditions, the terrific shell fire, etc., which prepared the nervous system for them, Oppenheim found mental affections infre-

quent and only where a history of previous psychosis, alcohol or head traumatisms clearly accounted for them. Even the latter seldom cause insanity; it was observed in only $1\frac{1}{2}$ per thousand head injuries during the Franco-Prussian war. Amnesia, functional or organic, may occur following traumatisms of the head, but as a rule it is transient; illusions of identity and fabulation have been observed. Lacerations or other gross lesions of the brain in children may entail traumatic dementia or idiocy. The rôle of the ductless glands in the various forms of insanity is given in the seventh volume, page 657, to which the reader is referred.

Besides these more prominent morbid effects of traumatisms are others as varied as they are numerous. *Cerebral concussion* may awaken no immediate serious symptom at first, but do so a few hours or days later, their nature depending upon the seat of the lesion. This applies also to *skull fractures*, the prognosis of which is usually serious. *Spinal concussion* is prolific in morbid effects, even at times where the traumatism is apparently slight, particularly in railway accidents. Locomotor ataxia was formerly the main disorder attributed to such accidents, but the Wassermann reaction, the reflexes, and other modern tests now make it possible to establish the true identity of the disease. Chorea and paralysis agitans may be mentioned among the syndromes that have been attributed to traumatism.

In determining the actual status of a case, especially if the patient is involved in a litigation, numerous factors, besides the purely clinical features, must be taken into account. Among these may be mentioned: Cupidity as the basis of the claim with malingering as possible consequence; autosuggestion, the predominant factor being an ideational complex in the complainant's mind; worryment entailed by the lawsuit as a factor in perpetuating and even aggravating the case, a feature taken advantage of by corporation law-

years. An early settlement is always advisable.

Segregation of early cases of war neurosis, each patient being in a special tent or room, is of value, if the patient is made to feel he has been selected for special care. Cheerful, mutual confidence and optimism are essential. Symptoms produced mainly by emotional shock or suggestion are treated chiefly by psychic methods; those due to physical concussion or exhaustion, by rest, massage, diet, electricity, etc. Those due to intoxications are treated by drugs, *e.g.*, for tachycardia, insomnia, etc. Other cases may require a mental hospital. Stewart (Arch. of Neurol. and Psychiatr., Jan. 1, 1919).

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VASCULAR SYSTEM, SURGICAL DISEASES OF.—ACUTE

ARTERITIS.—Inflammation of an artery occurs during repair of an injured vessel or following embolism in the absence of infection (*acute plastic arteritis*), but is here applied to inflammation due to bacterial infection. It is often due to neighboring inflammatory processes (*acute suppurative arteritis*). If the infection enters through the connecting blood or lymphatic channels, the disease may start with the inner vascular coat; from a septic wound, the process attacks the adventitia first. A thrombus from a distant purulent process may not only impair the lumen, but lead to sloughing and aneurism formation or perforation. In some cases of arteritis restoration of the vessel occurs; in others, a fibrous cord results.

Symptoms.—These vary somewhat with the degree of stenosis. There is pain over the vessel, tenderness, and usually some local loss of muscular power. If the artery is superficial, it is tense and cord-like. Pulsation may be absent. When the collateral circulation is not formed sufficiently early there is danger of gangrene. Again, from infectious thromboarteritis metastatic abscesses may appear elsewhere.

Treatment.—Absolute rest is indicated, with warmth of the part, opium to relieve pain, and nourishing food and tonic.

Mercurial ointment, diluted with petrolatum, according to the age of the patient, assists repair if applied with a cotton pledget along the course of the artery. Ammonium chloride, 5 grains (0.3 Gm.), every three hours, is said to encourage dissolution of any thrombus present. Other measures are suggested under Phlebitis.

PHLEBITIS.—Inflammation of a vein, as here understood, involves direct entrance of bacteria into the vascular tissue.

Acute phlebitis usually results from some injury accompanied by infection. It is sometimes very grave, leading to pyemia. The *subacute* form, less grave, is usually caused by some disease of the vessel accompanied by thickening and narrowing of the lumen.

Symptoms.—Inspection may show a dull-red line, with discoloration and edema below the obstruction. There is great tenderness, and the vein is felt as a hard, knotty cord. Pain and stiffness in the limb are noted. An increasing pulse rate, without fever (Mahler's symptom) is held suggestive of beginning phlebitis.

In phlebitis of deeper veins deep-seated pain and tumefaction are noted. Constitutional symptoms are seldom serious unless there is pyemia, due to detachment of small septic emboli, when fever, rigors and joint-pains may occur.

In the subacute form, if occlusion occurs, an abscess may form. But unlike arteritis, there is no hemorrhage. Acute phlebitis may follow, however, through rupture of the abscess into the vein. Pyemia may thus also ensue.

Etiology.—Phlebitis may be caused by varicose veins, traumatism, any inflammatory focus near a vein, primary thrombosis (*thrombophlebitis*), or constitutional states, such as gout, rheumatism, syphilis, chlorosis, infectious fevers, and tuberculous or cancerous cachexia. Postoperative phlebitis, believed usually of aseptic nature, develops oftenest in the left femoral and iliac veins, and occurs chiefly after abdominal operations on the uterus and ovaries, in anemic patients, and after operations for varices.

Prognosis.—Phlebitis complicating any severe constitutional disease, especially pyemia, is very grave. Simple phlebitis seldom results fatally, but detachment of

a large embolus resulting from aseptic thrombosis may result in sudden death.

Treatment.—**Absolute rest** with **elevation** of the affected limb is imperative. A wash of **lead and opium**, an **ichthyol**, **mercury** and **belladonna** ointment (not to be rubbed in), or **hot fomentations** should be applied. **Leeches** often prove of value. Any abscesses should be **incised**, under strict antiseptic precautions. Suppurative inflammation of the vein itself indicates **excision**; if this is not possible, it should be **ligated** above the affected portion, **incised**, and **disinfected**. The diet should be easily digestible and nourishing, and the bowels kept open. After six or eight weeks, gentle superficial **massage** and **passive movements** may help in restoring circulation, and hastening absorption of edema.

VENOUS VARIX, OR VARICOSE VEINS.—This is a dilated and thickened condition of the veins, especially the internal and external saphenous.

Symptoms.—Superficial varices appear as tortuous, bluish, tumor-like masses. Dull pain is often present, with some loss of power and a feeling of weight in the part, and at times muscular cramps. The superficial veins are usually mainly affected. Saphenous varices are bilateral in over two-thirds of all cases. They may extend to the scrotum; occasionally, the superficial veins of the abdomen are all involved, a thick, bluish, arborescent mass of vessels projecting from the surface. Arteries sometimes also become involved, and the nearby nerves and muscles may undergo interstitial inflammation.

Infiltration of tissues is frequent, especially after walking or standing, but soon differs from true edema, in that it does not pit under slight pressure, because of lymphangitis and hyperplasia of the subcutaneous tissues. An eczematous eruption often appears, followed by a varicose **leg ulcer**. When ulceration involves a large varicose vein, dangerous hemorrhage may ensue. Another possible complication is thrombophlebitis, which, in favorable instances, may result in obliteration of the vein and spontaneous recovery.

Deep varices are rare and difficult of diagnosis, until the corresponding superficial veins dilate.

Etiology.—Varicose veins are favored by weakness of the venous walls, either inherited or induced by phlebitis, and by poor general health. Blockage of deep veins favors varicosity of superficial ones. The female sex is that more often affected. Prolonged standing, heavy lifting, tight garters, heart and lung diseases, and enlargements of pelvic or abdominal organs are determining factors.

Pathology.—The veins are lengthened and tortuous. Their inner coat may protrude in lobular masses through the thinned outer coat. The greatest dilatation occurs above the valves, which are later often sclerosed or rendered insufficient by the dilatation. Such insufficiency is proven by noting an impulse on coughing all along the vein, or by rapid filling of the vein from above downward after it has been emptied by recumbency and elevation of the limb, pressure being temporarily applied high up over the saphenous vein while the patient resumes the standing posture. Fibroid periphlebitis may fix the veins to surrounding tissues. Thrombi may lead to suppurative phlebitis or turn into *phleboliths* ("vein stones").

Treatment.—*Palliative measures* include treating the cause, building up general health, attention to the bowels, **rest in bed** with **elevation of the limb**, and **light massage** if the skin is normal. **Elastic stockings or bandages** are of value where there is pain, decided discomfort or edema, and should be applied and removed in recumbency, the skin being rubbed with **alcohol** after removal and **zinc stearate** dusted over the part before reapplication. Hemorrhage is controlled by elevation and pressure.

Radical treatment is indicated for marked pain, threatening rupture and hemorrhage, thrombosis, intolerance of elastic compression, insufficiency of the valves, obstinate ulceration or eczema, and varices over the tibial crest. When the varicose condition is unilateral and of small extent, **excision** may be performed by ligating the vein or veins above and below the varices, and removing the latter. Any deep anastomotic veins should be tied. Where the saphenous vein in the thigh is affected, **total saphenectomy** is advisable, either through an incision from the saphenous opening

down to the ankle or by enucleation of successive portions of the vessel through short incisions. This operation is expedited by the Mayo "stripper," or by the device of Babcock, who passes a long flexible probe, acorn-tipped at both ends, into and along the vein, exposes the distal acorn and by traction on it tears out 20 or more inches of the vein, which becomes firmly pleated against the large proximal acorn. Marmourian's device consists in passing in a long probe, fixing the vein firmly to an eye in its distal end, and extracting the vein inside-out by traction on its proximal end.

Trendelenburg's operation, less radical, is useful only where the valves in the perforating veins connecting the deep with the affected superficial vein are sufficient. Insufficiency of these valves is shown by a rapid refilling (in 30 seconds or less) of the saphenous in the standing posture when it is emptied in recumbency and pressure continued over the upper extremity of the vessel. The operation, which consists in excising about 4 inches of the internal saphenous at the junction of the middle and inferior thirds of the thigh, is at times followed by recurrence.

Other useful procedures are those of **Schede**, who makes a circular incision round the leg at the junction of its middle and upper thirds and ligates all veins then visible; **Phelps**, who ligates the saphenous at short intervals through 30 or 40 small incisions; **Friedel**, who incises the leg spirally, encircling it several times, from foot to knee, ligating all veins; **Cecca**, who sutures the deep fascia over the saphenous vein, and **Katzenstein**, who supports the vessel by suturing the sartorius round it.

VARICOSE ULCERS.—If a varicose ulcer is kept very clean with soap and water or 2 per cent. phenol and dusted with dermatol night and morning, and a rubber—or, better, elastic webbing—bandage is wrapped round the limb from ankle to knee, it often gradually disappears. Overlapping strips of adhesive plaster, passing two-thirds round the limb, are also very useful. Over the ulcer itself 2 per cent. copper sulphate or aluminum acetate, or spirit of camphor, may be applied. To stimulate granulations balsam of Peru or 2 per cent. silver nitrate may be used. Rest, eleva-

tion, and massage of the surrounding tissues are all of importance. In some cases liberation of the ulcer margins from the tissues beneath by curved incisions, or excision of the entire ulcer, may become necessary.

HEMORRHAGE.—This may be arterial, when the blood comes in jets and is bright red—except in asphyxia; venous, when it flows in a continuous stream and is dark in color, or capillary, i.e., an oozing, which usually ceases on exposure to air.

Hemorrhage may also be divided into primary, when it accompanies injury; recurrent, intermediary, reactionary, or consecutive, when it follows within twenty-four hours, during the period of reaction, or secondary, when it occurs any time after twenty-four hours.

Symptoms.—A slight hemorrhage is usually recovered from promptly, unless general health is impaired. In severe bleeding the surface becomes progressively paler, the lips white, the extremities cold, the pulse increasingly feeble and rapid, and the respiration frequent and sighing. Faintness is experienced, with loss of voice, buzzing in the ears, failing sight, and pupillary dilatation. Often cold perspiration is noted. Delirium, collapse, and even death may follow.

Treatment.—This is constitutional and local. The patient must be recumbent, with the head as low or lower than the body,—unless the bleeding be from the nose or ears, when the upright position is indicated. All clothes should be loosened and the temperature maintained with warm blankets and hot-water bottles. The femorals and subclavians may be compressed, or, better, the extremities bandaged (autotransfusion). When the bleeding has not been arrested, stimulants should be given only in extremis. If it has, 1 pint or more of hot normal saline solution containing 15 or more minims (1 c.c.) of 1:1000 adrenalin chloride should be given by intravenous infusion or hypodermoclysis. Hypodermic injections of ether, atropine, strychnine, and digitalin, with enemata of hot coffee and brandy, are also of value. Blood transfusion is best for saving desperate cases; next comes infusion of 5 to 7 per cent. acacia solution.

For local treatment see next section.

INJURIES AND WOUNDS OF VESSELS.

A. Arteries.—**CONUSION** of an artery may not cause any special symptom, but if it is badly injured its walls are apt to slough, causing hemorrhage. Aneurism or obliteration and gangrene may also result.

RUPTURE is favored by atheroma. When incomplete, it is associated with tearing of the middle and internal coats alone. The latter, curling up, may lead to thrombosis and occlusion. Or, there may follow an aneurism, or a hemorrhage due to erosion of the outer wall. Even in complete rupture hemorrhage may be scarcely noticeable if the inner coats act as a barrier. If there is no external wound the tissues become infiltrated with blood or a *diffuse (false) traumatic aneurism* results.

PUNCTURED WOUNDS, when large, may cause considerable bleeding; they are apt to be followed by traumatic aneurism.

INCISED WOUNDS, when transverse, often cause profuse bleeding; where longitudinal or oblique, hemorrhage is usually not great.

B. Veins.—Injuries and wounds of veins are not, as a rule, followed by results as serious as in the case of arteries. Different from arterial bleeding, venous hemorrhage may be stopped by pressure on the distal part of the injured vessel.

Treatment.—In addition to the constitutional treatment already referred to, **cold** in the form of ice, or **heat** in the form of **hot-water** at about 120° F., locally applied, often arrest hemorrhage. **Elevation** is of some service in bleeding from extremities.

Pressure may be applied with the finger, by compresses secured by bandages over the bleeding point or main artery, or in the flexure of a joint, and by firm gauze packing. Edema and gangrene must be guarded against. In the extremities, a **tourniquet** placed above the injury is immediately dependable, but its removal must not be long delayed.

The **actual cautery**, if used, must be a very dull red.

Styptics include **adrenalin**, 1:1000 to 1:10,000, especially useful for mucous membranes, **alum**, **antipyrin**, **tannic acid**, **silver nitrate**, **coagulin** (animal blood platelets), and **thromboplastin** (brain emulsion). Internally, **calcium lactate**, **styp-**

ticin, **ergot**, **turpentine**, and **dilute sulphuric acid** may be used. **Subcutaneously**, 2½ to 10 drams (10 to 40 c.c.) of **human**, **horse**, or **rabbit serum**, or of **diphtheria antitoxin**, or **antistreptococcic serum**, may be given. **Gelatin**, in 1 to 10 per cent. solution, very carefully sterilized, may also be administered by this route.

In applying **acupressure**, a **harelip-pin** or **needle** is passed through the skin under the artery and out on the opposite side, when a figure-of-eight ligature is thrown around the ends of the pin. Or, the pin or needle may be inserted parallel to the artery, next rotated until perpendicular, then carried across and in front of the artery, to be deeply inserted into tissues of the opposite side.

Forcipressure, or vigorously crushing with forceps, is useful, especially for small vessels, but sometimes serves likewise for large,—as a rule, before ligation.

Torsion is done by twisting with forceps until there is no sense of resistance,—without, however, twisting the vessel off.

Ligation is the best method for all vessels visible with the naked eye. Silk or catgut ligatures are to be preferred and must be aseptic. A ligature should be applied to both ends if the artery is entirely severed, and on both sides of the wound if partially severed. If the distal end cannot be found, the proximal end is tied and a compress placed over the wound. Where it is impossible to tie the vessel in the wound, ligation in continuity is performed.

A **suture ligature** is one passed not directly around the vessel, but in a broader loop through the tissues surrounding it. It is used where there is danger of the ligature slipping; where the vessel is fixed in dense tissues; in necrotic tissues, and where the vessel is atheromatous.

Angiorrhaphy (vessel suture), maintaining the circulation through the injured vessel, is frequently advantageous or even imperative in wounds of arteries (or veins) of the size of the radial or larger. The risk of cutting through of the sutures is held to be no greater than in the case of a ligature (Stewart), and even if thrombosis should follow, extra time is given for the establishment of collateral circulation. The vessel having been shut off above with rubber-coated clamps or by external

pressure, in the case of a wound occupying not over one-third the circumference of the vessel, the margins of the injury are smoothed, if necessary, with a sharp bistoury, and covered with petrolatum to obviate drying. Guide sutures may be inserted at either extremity of the injury, to render the later suturing easier. Very fine needles and silk, sterilized in boiling petrolatum, are used. A continuous suture closing the wound is then inserted, special care being taken to bring the opposite margins of the intima in contact. A vessel more extensively wounded is best completely divided, and an end-to-end union accomplished after both extremities have been cut off square. Three equidistant guide sutures are placed through both vessel ends, the margins stretched somewhat by traction to reduce the chances of later stricture, and a continuous suture around the wound introduced. The vessel having been closed, blood is gradually allowed to run through from above, the line of suture being pressed upon until hemorrhage from the suture-holes is arrested. The vessel-sheath, previously slightly retracted, is next sutured, and then the fascia and skin.

SECONDARY HEMORRHAGE.—In secondary hemorrhage from a stump, **pressure** and **elevation** may arrest it. If not, the wound is reopened and the bleeding vessel **ligated**. If, however, the wound is nearly healed and there do not seem to be many clots, the hemorrhage is controlled by securing the main artery just above the stump, and either applying **acupressure** or cutting down and **ligating** it.

VENOUS HEMORRHAGE.—A hemorrhage from small veins usually ceases of itself. **Pressure** on the distal side is of value for veins somewhat larger. When large veins are injured, however, **ligation** is indicated. Sometimes this need only be a **lateral** ligature, applied after drawing up the margins of the venous wound in the shape of a cone with forceps. Phlebitis and gangrene seldom follow.

THROMBOSIS.—A *thrombus* is a blood-clot forming in the heart, blood-vessels, or lymphatics during life. In thrombi of slow formation, or due to projections from the interior of vessels, red cells may be absent and the thrombus nearly colorless.

Varieties.—A thrombus situated where coagulation began is a *primary* thrombus; when it gradually extends, an *extension* or *induced* thrombus. A thrombus adherent to the vessel-wall is a *lateral* or *parietal* thrombus; when it fills the vessel, an *occluding* or *obliterating* thrombus. Subsequent changes, allowing blood to flow through, result in a *canalized* thrombus. Finally, a thrombus may be *venous*, *arterial*, *cardiac*, *capillary*, or *lymphatic*, the first site being most frequent.

Symptoms.—If a main venous trunk be obstructed and collateral circulation not rapidly established, there occur passive hyperemia, venous dilatation, edema, occasionally hemorrhage in the vicinity, and in extreme cases moist gangrene. According to the situation, there may occur hydrothorax or ascites, anasarca of an extremity; hemorrhage from the stomach, intestine, or kidney; cyanosis and edema of the face and neck, etc. Thrombosis of the mesenteric arteries or veins, attended with sharp pain and melena, usually leads, sooner or later, to gangrene of the bowel, and is nearly always fatal without operation. The symptoms of arterial thrombosis in general are mainly those of arterial embolism. (See EMBOLISM, in the fourth volume.)

Etiology.—Thrombosis may be due to alterations in the intima, producing an obstruction or roughening, or to foreign bodies or septic germs. Hyperinosis, or excess of fibrin factors, and diminished fluidity, as in cholera, may be predisposing causes. Of all causes, however, retardation of circulation is most important.

The chief causes of *venous* thrombosis are two. The first is injury, nature arresting hemorrhage by the formation of thrombi. The thrombus may extend, causing occlusion of distant veins. The second cause is inflammation,—though in many cases of phlebitis, thrombosis is the primary lesion. Other causes are: pressure on veins; dilatation; arrest of circulation in the capillary district of the vein, from embolism or inflammatory stasis; weakened heart action, as in marasmus and other exhausting diseases. In the latter varieties thrombosis occurs mostly in the lower extremity and pelvis, less often in the sinuses of the dura mater.

Arterial thrombosis may be caused by wounds and injuries, degeneration of the intima, aneurism (by stagnation coagulation), and any condition, as embolism, producing circulatory arrest.

Cardiac thrombosis may be caused by endocarditis or by imperfect evacuation of the cavities due to valvular stenosis or lack of myocardial tone.

Capillary thrombosis may occur by extension from veins and arteries, or be primary.

Lymphatic thrombosis may be due to abnormal coagulability of the lymph, to tuberculous or other infection, or to cancer. It is mainly observed during puerperal fever, in the uterine lymphatics and their continuations to the lumbar glands, more rarely in the thoracic duct, or the axillary or inguinal lymphatics.

Pathology.—The first changes in a thrombus are shrinkage and decolorization. It may dry up until leathery or even calcified (phleboliths). Or, it may soften, beginning in the center, forming a milky fluid consisting of oily, granular *detritus*. Suppuration occurs occasionally in venous thrombi surrounded by, or leading from, inflamed parts. The vein wall, in these cases, is itself always inflamed. Such broken-down thrombi are a common cause of embolism.

Finally, the thrombus may organize, a vascular reticulated connective tissue being formed. Dilatation of newly formed channels gradually canalizes the thrombus, which may eventually disappear.

Treatment.—This is mainly prophylactic. Rigorous postoperative care of the patient, with centripetal massage and active movements of the limbs, are of prophylactic value. Citric acid, 30 grains (2 Gm.), 3 times a day, may be administered, or sodium citrate, in the same amount, added to each pint of milk. In actual thrombosis the part must be kept at rest until organization or absorption has occurred. Morris (1917) reported excellent results in thrombosis during infections from intravenous injection of $\frac{1}{2}$ pint (225 c.c.) of 0.5 per cent. sterile solution of sodium citrate in normal saline. Further treatment of thrombosis is largely that of phlebitis and embolism. (EMBOUSM, FOR EMBOLISM, and AN EMBOLISM, Vol. IV.)

PHLEGMASIA ALBA DOLENS.—

Phlegmasia alba dolens (milk-leg; white leg; marble-leg) is a swelling of one or both lower extremities, either ascending from the ankle or beginning at the groin and extending down the thigh, occurring usually between the tenth and twentieth days after confinement, or some days or weeks after an abdominal operation.

Symptoms.—As a rule, slight fever precedes; exceptionally, the onset may be announced by a distinct chill. Sometimes malaise, with gastric disturbance, anorexia, coated tongue, and constipation exist for a day or two before pain in the limb is complained of. Another possible premonitory symptom is pain and tenderness in the uterine region, especially on the corresponding side. The first characteristic symptom is a dull, dragging pain in the limb, increased by motion. As a rule, acute pain soon develops along the femoral vein, in the calf, or above the ankle. In these situations the thrombosed veins can sometimes be felt. The pain and tenderness then extend all over the affected parts. The pain is sometimes along the internal saphenous vein.

Concurrently with the pain, or a day or two after, swelling is observed, which gradually spreads and hardens. This swelling, when fully developed, is very tense and resilient, and does not pit on pressure. It may spread at once all over the limb, but often either descends from Poupart's ligament or ascends from the ankle. Involvement of the upper or lower part of the limb alone is rare. The swelling affects the limb evenly, and rounds off its figure, but does not destroy its form as in anasarca. Coagulable lymph exudes if the skin be pricked. An erythema is occasionally noted over parts of the limb; it may be confined to a narrow path along a subcutaneous vein or lymphatic. Voluntary motion is almost completely abolished. The temperature rarely exceeds 102° F. (38.9° C.).

The ordinary termination is absorption of the thrombus and restoration of circulation. The rate of recovery varies greatly. In a favorable case it may be several weeks before the disease disappears; in other cases further or even indefinite delay may occur.

Diagnosis.—From edema with phlebitis or accompanying varicose veins the history will usually permit differentiation.

Etiology.—This disorder is oftener observed in the puerperium. It is probably favored by the natural formation of thrombi in the uterine sinuses after delivery.³ It may follow operation on an abdomen apparently free of infection. Other predisposing conditions are convalescence from fevers, especially typhoid, dysentery, and disease of the rectum, fibroids, arrest of the menses, and general malignant or tuberculous disease. The disorder has often been observed in the leg on the side of a previously commenced pleurisy.

Pathology.—In some cases the disorder may be considered the extension of an inflammation from the genitalia to the perineum, nates, and upper thigh, secondary thrombosis resulting. In others, thrombosis is apparently the initial lesion. It may be spontaneous, from retardation of the blood-current; varicose veins favor it. The iliac and its tributaries, the tibial and the peroneal veins are the vessels usually involved, as a rule, on the left side. The intravenous coagula may, however, take origin at the placental site, and, extending along the pumpiniform plexus to the hypogastric vein, thence occlude the iliac vein to Poupart's ligament, or, passing up by the spermatic veins, they may obstruct the vena cava.

Complications.—Among the complications are inflammation and suppuration of the pelvic joints, erysipelas, abscesses of periphlebitic origin, cellulitis, and gangrene of the lower portions of the limb. The more fatal complications are embolism (sometimes cerebral), pyemia, and septic pneumonia.

Sequelæ.—The most frequent sequel is persistent aching of the limb, increased by cold, dampness, derangement of health, and exercise. More or less persistent edema of the ankles, motor weakness, and muscular atrophy or contracture have been observed. Exceptionally, great hypertrophy of the cellular tissue coexists with muscular atrophy; it may be associated with extensive and intractable ulceration.

Prognosis.—This depends on the cause and complications. Death from pulmonary embolism is always possible until the

thrombus has disappeared or become organized. Embolism has proved suddenly fatal as late as 37 days after delivery.

Treatment.—The principal indications are: **Opium** to relieve pain, **cathartics** for constipation; **quinine**, iron, good food, and other sustaining measures, and **rest** of the swollen limb for 4 to 6 weeks. The latter should be supported on a pillow raised at the foot, with the bedclothes kept off by a cradle. **Cold** should be used locally the first day, followed by **wrapping** the limb in **cotton-batting** sprinkled with equal parts of **belladonna** and **chloroform** liniment, with oil-silk outside and **external heat**. Remedies for rheumatism or gout should be given if indicated. Where the vein is manifestly suppurating, the affected portion should be **excised** or, if this is not practicable, ligated above and below, **incised**, and the infected clot **washed out**.

If vesicles form, they may be punctured and evacuated. When the swelling is subsiding, and tenderness begins to diminish, absorption may be promoted by gentle frictions with **alcoholic lotions** and by applying a light, flannel, roller **bandage** evenly over the entire limb. The patient must not be allowed to leave bed until every trace of tenderness and thickening has disappeared. For some time the patient should wear a long **elastic stocking**, as the limb will swell from standing or protracted exercise. **Rubbings**, **bandaging**, and **faradization** may be required to relieve swelling, edema, and muscular weakness. In applying frictions the danger of dislodging a thrombus must not be overlooked. D. and S.

VASOMOTOR NEUROSES.

See VASCULAR SYSTEM, DISORDERS OF.

VEINS, DISORDERS OF. See VASCULAR SYSTEM.

VENESECTION AND BLOOD TRANSFUSION.—**VENESECTION**, or **phlebotomy**, formerly used extensively in therapeutics, has largely fallen into disuse, yet in suitable cases is a measure of great value.

Technique.—A large vein, usually the median basilic, is made prominent by

pressure above, either with the finger or a bandage or by twisting a handkerchief about the arm, care being taken not to cut off the arterial supply. The skin over the vessel is incised for half an inch and the fascia carefully separated till the vessel itself, blue and shining, is exposed. A small longitudinal incision is then made into the vessel, the knife being held with the cutting edge upward and care being taken not to injure the posterior wall of the vessel; or the vessel may be snipped with a small pair of scissors. When enough blood has been removed, usually ascertainable by the pulse of the other arm, the constriction is removed and a sterile compress applied.

Indications.—Bleeding is useful in cases of pneumonia, pleurisy, and meningitis if the arterial tension is high, and in any case in which there is congestion, local or general, and arterial excitement. In pneumonia with engorgement of the right ventricle early bleeding will equalize the circulation, relieve the laboring heart, and dispel dyspnea and cyanosis. Though seemingly indicated in apoplexy, where the pulse is hard and tense, Cushing holds it inadvisable. In toxic conditions such as septicemia, uremia, diabetic coma, and the toxemias of the infectious fevers, bleeding and saline hypodermoclysis or intravenous infusion simultaneously performed, are often life-saving. Theilhaber (1916) believes withdrawal of 400 or 500 c.c. of blood twice a year does much to prevent recurrence or metastases in cancer cases.

BLOOD TRANSFUSION.

Technique.—To obviate hemolysis or agglutination, a preliminary test, the two bloods being mixed *in vitro* for 24 hours, is advisable. R. I. Lee mixes on a slide serum from the donor and blood from the recipient dropped into 10 times the amount of 1.5 per cent. sodium citrate solution, and examines microscopically in a few moments for agglutination. A further device (1918) is the division of blood samples into 4 definite groups differing in their transfusion compatibilities and the testing of prospective subjects with pre-selected standard specimens.

In Crile's method of *direct* transfusion the donor's radial is brought in contact

with a superficial vein of the recipient by means of a small, sterilized, silver tube (Crile's tube) having two circular grooves. The proximal end of the donor's vein is passed through inside the tube (previously dipped in sterile olive oil), cuffed out over its end and tied to it by a ligature over the second groove. The artery is then drawn over the everted vein and tied in the second groove. Brewer simplifies the procedure by using a plain tube dipped, after sterilization, in melted paraffin, which, on cooling, prevents clotting and permits of merely drawing the artery over one end and the vein over the other and fastening by ligatures. In each method the radial artery is exposed under local anesthesia, and the artery and vein are cut between a ligature and a clamp. In Fauntleroy's method a vein-to-vein (arm-to-arm) transfusion is performed through a semicircularly bent or S-shaped tube (previously paraffined), according to the relative positions of the donor and donee; a constricting band is kept round the donor's arm during the transfusion sufficiently tight to maintain venous hyperemia in the forearm. In artery-to-vein transfusion the flow is hastened by dilating the artery with a flow or compress of warm normal saline solution over it. In either method, when enough blood has been transfused—usually after 15 or 20 minutes,—or the donor's pulse begins perceptibly to weaken, the tube is withdrawn, the vessels are ligated, and the skin wounds closed. Before this is done in the case of the donor, however, saline solution equal to the blood lost may be run in.

A later modification in the technique of transfusion consists in making it *indirect*, *i.e.*, collecting the blood in a receptacle before introducing it in the recipient. A glass cylinder with side outlets at the bottom and near the top is sometimes used. It is sterilized and coated with sterile paraffin. By the use of the sodium citrate method, the blood can be either administered forthwith or preserved for later use at intervals up to four weeks, and paraffin coating of the receptacles is unnecessary. Newell (1918) draws blood into a 200-c.c. syringe containing 2 cc. of 2 per cent. citrate solution and injects it from the same syringe.

With Quoyrat's needle, 300 to 500 c.c. (10 to 18 ounces) of blood can be withdrawn without any incision and collected in a sterile receptacle, meanwhile constantly shaken, containing 0.1 Gm. ($1\frac{1}{2}$ grains) of sodium citrate for each 100 c.c. ($3\frac{1}{4}$ ounces) of blood. The blood is then reinjected from a wash bottle with rubber bulb. The blood can be kept at 37° C. as long as four days. P. Ameuille (Bull. de l'Acad. de méd., Feb. 12, 1918).

In the average transfusion about 600 c.c. of blood are transferred. For infants from 90 to 120 c.c. of blood are transfused, usually with the needle inserted into the longitudinal sinus at the posterior angle of the anterior fontanelle, exactly in line with the sagittal suture.

Indications.—Blood transfusion is of great value, as has been further proven in the European war, after violent or prolonged hemorrhage. The blood not only tends to arrest hemorrhage or prevent secondary hemorrhage, but simultaneously supplies a highly concentrated form of nourishment; hemolysis, even upon using a stranger's blood, is rare, and if it does occur, half a pint of blood will not overwhelm the recipient (W. R. Morrison). In hemorrhagic disease of the newborn transfusion has given very satisfactory results. It is useful in severe hemorrhage in typhoid fever, and in hemophilic or jaundiced cases with slow blood coagulation requiring operation, and in cases of exhaustion in general, is a valuable pre-operative measure. In anemias, the results have been somewhat disappointing, but transfusion is, nevertheless, sometimes useful as an ultimate therapeutic means. Precautions to avoid transmission of syphilis or other infections from donor to recipient are, of course, always advisable.

W. and S.

VENOMOUS BITES. See INDEX-SUPPLEMENT.

VERATRUM.—*Veratrum viride* is defined (U. S. P.) as the dried rhizome and roots of *Veratrum viride* (green or American hellebore), of the family Liliaceæ. The white or European hellebore (*Veratrum album*) is no longer official (U. S. P.

IX). The chief constituents of the two plants probably differ; that of *veratrum viride* is held to be *cevadine* ($C_{32}H_{48}NO_9$), that of *veratrum album*, *protoveratrine* ($C_{32}H_{51}NO_{11}$). Each plant contains, in addition, the lesser alkaloids, *jervine* and *rubijervine*, and an acrid, irritant resin; *veratrum viride* also embodies *veratridine* and *pseudojervine*. Much of the *veratrum* used in the United States has been derived from *veratrum album*.

Veratrine, as officially recognized, is not a single chemical substance derived from *veratrum*, but a variable mixture of several alkaloids—*cevadine*, *cevadilline*, *sabadine*, *sabadinine*, and *veratridine*—obtained from the seeds of *Asagraea officinalis* (sabadilla or stavesacre), of the family Liliaceæ.

PREPARATIONS AND DOSES.—*Veratrum viride*, U. S. P. (*veratrum*). Dose, 1 to 2 grains (0.06 to 0.12 Gm.).

Fluidextractum veratri viridis, U. S. P. (fluidextract of *veratrum viride*). Dose, $1\frac{1}{2}$ minims (0.1 c.c.).

Tinctura veratri viridis, U. S. P. (tincture of *veratrum viride*), representing 10 per cent. of the drug. Dose, 5 to 30 minims (0.3 to 2 c.c.); official dose, 8 minims (0.5 c.c.).

Veratrina, U. S. P. (*veratrine*), occurring as a grayish-white, amorphous powder, practically insoluble in water, soluble in 2.2 parts of alcohol. It is odorless, but causes irritation and sneezing even in minute amounts, and has an acrid taste, followed by numbness of the tongue. Dose, $\frac{1}{100}$ grain (0.002 Gm.).

A 2 per cent. oleate and a 4 per cent. ointment of veratrine were formerly official (U. S. P. VIII).

PHYSIOLOGICAL ACTION.—**Locally**, all *veratrum* preparations are very irritating to mucous membranes, inducing violent sneezing and coughing when inhaled, and a pricking and burning in the mouth when orally taken.

Veratrine ointment applied to the skin causes pricking and warmth locally, due to excitation of the sensory nerve-endings followed after a time by numbness and cold.

General Effects.—The chief systemic action of *veratrum* is seemingly exerted on the vagal cardioinhibitory center in the medulla, which, by large therapeutic doses,

is strongly excited, causing a marked slowing of the heart rate and a corresponding fall in blood-pressure. According to R. J. Collins, from 30 to 75 minims (2 to 5 c.c.) of a 10 per cent. tincture of *veratrum album*, in divided doses, is required to produce distinct effects of this kind, i.e., a slowing of the rate by 12 to 42 beats per minute, a drop in the systolic blood-pressure of about 39 mm. of mercury, and in the diastolic pressure by 8 to 32 mm. Such doses are sometimes followed, half an hour after the circulatory effect reaches its maximum, by nausea and vomiting, probably due chiefly to medullary stimulation, perhaps coupled with local gastric irritation. A tendency to stimulate the vasoconstrictor center in the medulla has also been attributed to veratrum, but if this actually occurs, the resulting vasoconstriction is insufficient to prevent the fall of blood-pressure due to slowing of the heart. According to Pilcher and Sollmann veratrum viride is without direct action on the vasomotor center, while according to Cramer it produces vasodilation through a reflex action on the vasomotor center. Cevadine and protoveratrine both stimulate striated muscle tissue, the former probably slightly stimulating the heart muscle in therapeutic doses; in addition, cevadine in large amounts, especially in the frog, causes a characteristic slow relaxation and delayed fatigue of striated muscle tissues.

UNTOWARD EFFECTS AND POISONING.—Large doses of veratrum may cause, in addition to marked cardiac slowing, fullness and throbbing in the head, nausea, and vomiting. Frankly toxic amounts induce also profuse sweating, diarrhea, and dysphagia. The pronounced bradycardia is suddenly replaced, in lethal cases, by extreme cardiac acceleration, a temporary rise in blood-pressure, followed by collapse, sometimes convulsions, paralysis, and death by respiratory failure.

Treatment of Poisoning.—The vomiting so constantly and early provoked by large amounts of veratrum tends to obviate disastrous results from such amounts, the drug being safer for this reason than aconite. Where poisoning occurs the evacuation by vomiting may be assisted with large draughts of warm water. Absolute

rest in recumbency, external heat, atropine in full dosage hypodermically to release the cardiac inhibition, and morphine hypodermically or opium by rectum, for continued, exhausting vomiting are all important measures. To these may be added cardiovascular stimulants, peripheral stimulation by rubbing with coarse towels or mild flagellations, and artificial respiration.

THERAPEUTICS.—The chief use of veratrum is as a circulatory sedative in conditions associated with high blood-pressure. The dosage required for pronounced effects has already been referred to under Physiological Action. Such amounts should be given in divided doses, each dose with at least one glassful of water, to reduce gastric irritation. The effect of these amounts is likely to persist at least six hours—diminishing gradually meanwhile—after the last dose.

In **puerperal eclampsia** with high blood-pressure tincture of veratrum in large doses is extensively used, causing a marked hypotensor effect and allaying convulsions. If one adheres to the view that veratrum lowers blood-pressure solely by slowing the heart rate, combined use of a nitrite, it would seem, might be of advantage to enhance the hypotensor action.

In **uremic convulsions** results similar to those in eclampsia may be obtained with large doses. According to Gilardoni one may, by constant use of veratrum in moderate dosage, secure a continuous depression of blood-pressure in such conditions as **chronic nephritis**, **arteriosclerosis**, and **vascular hypertension** of unknown origin. For this purpose the drug should be given at three-hour intervals. Pesci, in such cases, gives 30 to 60 drops of the tincture daily for nearly a week, next suspends the drug for a few days and then resumes it; he also reports good results from similar doses in lead colic. In **excessive cardiac hypertrophy** and in the irritable heart of strong but overworked men, veratrum in smaller doses, is by many considered of value. In advanced **aortic aneurism** with high blood-pressure, the drug may be used with great care to reduce the pressure and with it the chance of vascular rupture. J. S. Todd warmly recommends combination of 1½ minims (0.1 c.c.) of Norwood's tincture with every dose of

digitalis in cases where an undesirable peripheral vasoconstricting effect of the latter remedy is apprehended.

In acute, athenic, incipient inflammations, including cases of pneumonia, bronchitis, hepatitis, salpingitis, etc., veratrum has been used with asserted benefit. That small doses of the drug, perhaps combined with morphine and sweet spirit of niter (Bates), will in such patients tend to soften and slow the bounding pulse, and moisten and relax the skin, seems clear. Whether such effects will actually benefit by reduction of congestion in the diseased area is a question open to discussion.

Veratrum is contraindicated in the presence of marked depression or exhaustion, as well as in cases in which harm from possible vomiting, as in peritonitis or gastritis, is apprehended.

Veratrine is used externally, usually in ointments, for the relief of local neuralgias and myalgias. Danger from absorption is said, however, to attend free use of the oleate of veratrine. S.

VERONAL.—Veronal, diethylmalonylurea or diethylbarbituric acid, occurs as a white, crystalline powder having a faintly bitter taste, and soluble in about 150 parts of cold and in 12 parts of boiling water. The sodium salt, veronal-sodium, sodium diethylbarbiturate, or medinal, dissolves in 5 parts of water. The average dose of either preparation is $7\frac{1}{2}$ grains (0.5 Gm.). Both drugs are best taken on an empty and acid-free stomach—on retiring. In some cases—cardiac and bronchial asthma—veronal-sodium is given *per rectum*, dissolved in a dram (4 c.c.) of water and injected with a small rectal syringe. Subcutaneous injections—75 minims (5 c.c.) of a 10 per cent. solution—are intensive rather than rapid in effect, and are recommended only in special cases—where patients refuse oral medication, in threatened delirium tremens, in antinomorphine treatment, and in grave insomnia.

PHYSIOLOGICAL ACTION.—In normal individuals, or those suffering from mild insomnia, veronal induces quiet sleep in from 20 to 45 minutes. In robust patients, with more severe insomnia, 15 grains (1 Gm.) may be required. Sleep

lasts for 8 to 12 hours. A few, especially elderly patients, experience slight vertigo on rising, apparently due to a reduction in blood-pressure. The pulse rate is lowered and the respirations are more shallow. The skin may become paler, but is never cyanosed. As small a dose as 5 grains (0.3 Gm.) may produce dizziness. After prolonged use patients may suffer vertigo, weakness in the limbs; the urine may be scanty and dark. In those suffering from delirium or mania, or in a state of mental hebetude, there is a tendency to ignore bodily functions, and occasionally urinary retention occurs. Cumulative effects are sometimes noted.

POISONING BY VERONAL.—Toxic symptoms are: vertigo, diplopia, staggering gait; dark, scanty urine, sometimes with retention; feeble pulse, shallow respiration, gradual coma, and death. Dermatitis has been noted. The average lethal dose is from 120 to 150 grains (8 to 10 Gm.). Veronal is contraindicated in acute nephritis, in myocarditis and aortic regurgitation, and in insomnia due to pain. Clinically veronal is incompatible with calomel if administered close together, great depression being caused.

Treatment of Poisoning by Veronal.—No hot drinks should be given if it is suspected that the stomach contains any unabsorbed veronal, as these will hasten absorption, but lavage of the stomach with the stomach-tube is indicated. Hot tea or coffee should then be given freely, by stomach-tube, if necessary. The centers should be stimulated through the use of caffeine, camphor, etc. Venous congestion, especially in the abdominal area, must be overcome by compressing the abdominal vessels and raising the surface temperature by the application of external heat. Oxygen inhalations may be used. When the acute symptoms have subsided, potassium acetate, spirit of nitrous ether, and other diuretics, will aid in re-establishing the renal function.

THERAPEUTIC USES.—Veronal is useful in insomnia and excessive nervous restlessness, especially as seen in neurasthenia, psychasthenia (cerebral neurasthenia), acute alcoholism, maniacal excitement, epileptic mania, pareis with excitement, grave melancholia, especially

with suicidal tendencies or refusal of food, withdrawal treatment of morphinism and cocaineism, hysteria, seasickness, severe chorea, and vomiting of pregnancy.

A patient took fourteen 5 grain barbitol (veronal) tablets in divided doses over a period of 36 hours and slept continuously for 7 days. This prolonged sleep from veronal suggested its use in *status epilepticus*, with happy results from 30 grains (2 Gm.) in divided doses. Probably in other mental conditions, as *morphinomania*, etc., a week's sleep might eliminate the suffering from drug withdrawal. MacLeod (Med. Record, Dec. 11, 1920). W.

VITAMINES.—The outer coatings of grain and the quality of freshness in fresh vegetables have been shown to be of great importance in bodily nutrition. To the substances in the pericarp of rice counteracting beriberi, Casimir Funk, of London, in 1912 applied the name *vitamines*. Similar substances have been shown to exist in the pericarps of wheat, corn, rye, oat and barley grains. Though *vitamines* are present in only minute amounts, not a single animal fed on *vitamine*-free food, however varied and plentiful, was found able by Funk to live more than a short time. A given amount of *vitamine* will take care in the body of only a certain amount of carbohydrate food. In the experimental polyneuritis in fowls, even starvation proves much less quickly harmful than a diet only of polished rice. The more polished rice taken, the greater the certainty and severity of beriberi (Levene). In the absence of *vitamines*, according to Funk, metabolism goes wrong, as shown in a negative balance of nitrogen and of inorganic constituents, *e.g.*, Ca, P, and S.

In Seidell's experiments, pigeons with severe paralysis due to a polished rice diet plainly showed improvement within an hour after an injection of *vitamine*, and seemed entirely normal the next morning. *Vitamines*, as shown by Shie, have a striking influence on the growth of young animals, which may be completely stopped by *vitamine* deficiency. Marked changes in the chemical composition of the brain were found by Funk in animals fed on

shelled rice. The thymus gland, normally large and persistent in pigeons, atrophies completely under a polished rice diet. Changes in the pituitary and decided atrophy of the testes or ovaries also occur.

Diseases, other than beriberi now attributed by many to insufficient *vitamine* intake include scurvy, Barlow's disease, pellagra, rickets, and osteomalacia. Infection is probably also favored, the experimental animals suffering from an eye infection which promptly disappears upon addition of *vitamine*.

Less pronounced *vitamine* insufficiency in infants may cause restlessness, irritability, and greenish stools containing either mucus or curds (Fischer). Loss of appetite is an early symptom of *vitamine* deficiency, and is thought especially significant in children, chlorotics, and convalescents. Vomiting, diarrhea, and meteorism are other results.

If sterilization of milk becomes necessary during an epidemic, *vitamines* should always be supplied in some other form—meat-juice for young infants, potato purée or egg yolk for older children. In digestive disorders the diet must not be allowed to get too poor in *vitamines*. Desiccation destroys *vitamines* in fruit and vegetables; hence the lassitude from an antidiarrheic diet. A surplus of *vitamines* reduces the demand for calories. *Vitamine* deficit is probably a factor in chlorosis, anemia, neurasthenia, and vasomotor disturbances, and in fevers and convalescence an ample *vitamine* supply is imperative. Commercial infant foods are free from *vitamines*, and these must be added. E. Madsen (Ugeskr. for Læger, Apr. 18, 1918).

Liberal amounts of milk are necessary when milk is depended on for an appreciable proportion of the water-soluble *vitamine* in the diet. In reinforcing the calories by diluting the top milk and adding milk sugar, the food contains relatively less of the water-soluble *vitamine* than the original cow's milk; while the child's appetite is normal, the supply of *vitamine* may be sufficient, but if the food intake is reduced, the

vitamins supply is lowered, and endless dietary trouble may set in. T. B. Osborne and L. B. Mendel (Jour. of Biol. Chem., June, 1918).

Ramoino reported gastrointestinal disturbances, herpes, eczema, epistaxis, bluish gums, malodorous breath, pains in the joints, muscles, and head, loss of weight, mental dullness, and melancholia as being widely noticed among Italian troops as a result of deficient vitamins in the rations; when food rich in vitamins could be obtained all these symptoms generally subsided.

Cereals, meats, potatoes, fats, and sugar probably furnish too small an amount of vitamins to meet fully the requirements of an adequate dietary. Care should be taken not to undereat in green vegetables. Osborne

and Mendel (Jour. Biol. Chem., Jan. 1919).

At the present time too little is known concerning the vitamins to warrant decided assertions. As stated in an editorial in the British Medical Journal for February 11th, 1922, fresh vegetables contain an abundant supply of vitamins, while a considerable quantity is present in milk and meat, provided the animals from which these are obtained were fed on fresh foods. As the writer states: "A normal adult on an ordinary diet containing a reasonable proportion of fresh vegetables is, therefore, certain of obtaining a plentiful supply of vitamins." Yet, as stated by Mendel and Osborne, preference should be given to **green vegetables**. Commercial infant foods are also lacking in them; hence the need of orange juice, etc. S.

W

WARTS. See SKIN, SURGICAL DISEASES OF.

WATER (HYDROTHERAPY).

—Water as a remedial agent may be applied externally in solid, liquid, or vapor form; either hot or cold, pure or impregnated with mineral substances, carbon dioxide, or sulphur dioxide; it may be applied in pools, tubs, jets, or sprays, with or without pressure, or by means of sheets, or compresses.

Reaction.—The effect, or action of baths, either hot or cold, should be followed by a reaction, or return of healthy glow to the skin. This reaction is delayed in the weak and feeble; the reaction may be hastened by the application of cold after heat, by employing friction in the bath, and by using chemical stimulants, such as carbonic acid gas, and various chlorides, etc., in the water. When baths differ much in temperature from that of the normal body, it is highly important to secure reactions.

Temperature of Baths.—Temperature of water used in the various baths is as follows: *Cold*, 40°-65° F. (4.4°-18.3° C.); *cool*, 65°-75° F. (18.3°-23.8° C.); *tepid*, 85°-95° F. (29.4°-35° C.); *warm*, 95°-100° F. (35°-

37.7° C.); *hot*, 100°-110° F. (37.7°-43.3° C.); *very hot*, 110°-120° F. (43.3°-48.8° C.). Where vapor baths are employed: *Warm vapor*, 100°-115° F. (37.7°-46.1° C.); *hot vapor*, 115°-140° F. (46.1°-60° C.). Air baths are still higher in temperature; *warm air*, 110°-120° F. (43.3°-48.8° C.); *hot air*, 120°-180° F. (48.8°-82.2° C.), or more.

HYDROTHERAPEUTIC MEASURES.

—Many of these applications are made while the patient reclines in bed, which should be narrow, with woven wire spring mattress. Marble slabs are convenient when the patient is to be rubbed or shampooed, though a wooden table may be used. In preparing the bed, a rubber sheet is first spread, then a thick blanket.

The Cold Pack.—A sheet, saturated in water at 70° F. (21.1° C.) is wrung out slightly, and wrapped about the patient, around each limb, and snugly about the neck. A light covering may be used over the patient. Five or six renewals at intervals of five minutes may be necessary. Cutaneous circulation is promoted by friction with the hands outside the sheet. In fever patients the temperature falls.

Evaporation Bath.—Prepare the bed as before, place a hot-water bag at patient's feet and a cold compress on his head.

Cover the patient wholly with one thickness of gauze moistened in water at 115° F. (46.1° C.). Adjust the gauze closely to the skin. The patient is now fanned and the gauze is moistened, as evaporation takes place, with water still at 115° F. (46.1° C.). During fifteen minutes about one pint of water should be evaporated. The temperature of the water may be maintained by placing the basin used in a larger one containing hotter water.

In the absence of ice or cold water, cold applications may be made with ammonium nitrate, ½ pound dissolved in 1 quart of water.

The Cold Bath.—This includes the cold plunge and cold full baths.

In the *cold plunge bath*, vigorous friction is made to the body while in the bath and a large bath sponge is used to deluge the head and shoulders. Friction is made from one-half to three minutes. A quick, thorough rub with coarse Turkish towels and rapid dressing follow. This bath tones up flabby abdominal muscles and relieves gastrointestinal sluggishness, impaired nutrition, obesity, and autointoxication. It is also useful in mental torpor, lassitude, headache, and listlessness.

Cold full baths at 50°-60° F. (10°-15.6° C.) should last only a minute or less; if from 60°-70° F. (15.6°-21.1° C.), a little longer. A large tub is used and the entire body is submerged. A tonic effect is produced and respirations are deepened as in the plunge bath. The appetite and peristalsis are increased, and constipation prevented or lessened; it is useful in enteroptosis, intestinal dilatation, and autointoxication, and in typhoid fever (at 70° F.—21.1° C.).

These baths are *contraindicated* in spastic and mechanical constipation, acute inflammatory affections (appendicitis, peritonitis, and gastritis), in severe anemia, during gestation, in advanced life, and where arteriosclerosis is present. Bronchitis, cardiac weakness and emphysema are best relieved by hot sponge baths. The best cures by cold baths follow the temperate use of hot baths (Floyer).

The Half-bath of Priessnitz.—This is a shallow bath, the water reaching to the umbilicus, but used over the whole body. It is applied with water at 63°-75° F. (18.3°-23.9° C.) during from three to five

minutes, the water being 5 or 6 inches deep. The patient enters from a warm bed, or with circulation stimulated by exercise; the attendant rubs the chest vigorously for a few minutes, and then both limbs. The rubbing of the various parts is repeated once or twice. This bath is a powerful tonic and is useful in anemia, many chronic diseases of the spinal cord, in cardiac affections, and usually in those cases of asthma which do not bear the Turkish or Russian bath well, in constipation and chronic gastric affections. At the higher temperatures it relieves sciatica and all painful affections of the pelvis and lower extremities.

The Spray Bath.—This consists in the application through a large, perforated, rose nozzle, of a continual fresh layer of water in a finely divided state, with a certain mechanical impact, to the skin. This removes secretions and is a marked sedative to the nerves. This bath is especially useful in sunstroke, either alone or combined with ice rubbing; in typhoid fever the combination is especially efficient.

The Ablution or Wet-mit Friction.—In this the water is applied with a wet bath mitten. One portion of the body after another is rubbed first with water at from 50°-75° F. (10°-23.8° C.), and then with a rough towel. Alcohol may be added to the water if the circulation is poor. The rubbing should be continued until the skin of the part becomes red and warm. This method is used in the treatment of feeble and bedridden patients. When reaction becomes prompt and good, douches and other stronger measures may be used.

The Drip Sheet or Sheet Bath.—This is best given late in the afternoon or toward evening. For its application we need a pail of water at 65° F. (18.3° C.), a foot-tub with water at 100° F. (37.8° C.), ice-water, two face towels, a bath towel, a bed with an extra blanket, and protection for the floor. Place the sheet in the bucket of water, allowing the corners to hang out. The patient, dressed only in one thin garment, stands in the foot-tub containing the warm water. One face towel is dipped into the ice-water, wrung out and applied around the head. The pail of cold water containing the sheet is placed behind the patient, and the nurse,

standing in front, removes the wet sheet by two corners and wraps it around the patient, with vigorous, quick rubbing. This process should take about two minutes. The sheet is then dropped and the patient wrapped in the dry blanket and put to bed. If desired, the mechanical irritation of the skin may be increased by slapping the surface with the hand or a wet towel. Water 10° F. (5.4° C.) colder than the water used for the sheet should be dashed over the head and shoulders two or three times at short intervals, alternating with slapping and friction for from five to ten minutes. A moderately sedative effect, with the abstraction of considerable heat, is produced.

Sponging.—Have ready water at 80°-90° F. (26.7°-32.2° C.) and also some at 60° F. (15.6° C.). Before sponging take the exact temperature of the patient. Remove all clothing from the patient, place blankets over and beneath him and a hot-water bottle at his feet. Arrange the basins, sponges, and six soft towels on a table near the bed. First sponge the face and neck, applying a cold compress at 60° F. (15.6° C.) to the head after sponging. Sponge downward, exposing only the part being sponged. After the whole body has been gone over thoroughly dry the patient, put on him a night dress, wrap him in a warm blanket, and leave him undisturbed in bed for an hour or so. Take the patient's temperature after each sponging and at the end of the hour's rest. Sensitive patients will better stand cold sponging if they are previously sponged with tepid water, 80°-90° F. (26.7°-32.2° C.). In stronger ones the arms, back, and chest may be allowed to dry by evaporation. Sponging usually causes a decline of from 1°-4° F. (0.54°-2.2° C.), according to the temperature of the water used. Cooling by rapid evaporation is favored by the addition of ammonia, cologne-water, or vinegar to the water used. If a suitable sponge is not at hand, wring towels out of cold water so as not to drip and place this about the body from the neck downward. On reaching the feet, again begin at the head, etc. Sponging is beneficial in febrile conditions, especially in typhoid fever when the temperature is not above 102° F. (38.9° C.).

An abdominal cold compress is sometimes applied to enhance the effect of the sponging. Partly wring two towels out of water at 60° F. (15.6° C.), unfold them, lay them over the abdomen, and retain them with a thick Turkish-towel binder.

The Oil Rub.—After a warm or tepid bath the skin is dried and the oil is applied; it should not be applied when the skin is dry or unwashed. Pure olive, cocoanut, or palm oil is best, although cottonseed oil may be used. Animal fats are not suitable. The oil should be well rubbed into the skin and the surplus removed with a soft towel. For a successful oil rub the rubbing should be gentle and not cause perspiration. This measure is beneficial in sluggish cutaneous circulation and in dry, scaly, skin affections. An oil rub lessens the liability to chilling after hot baths, and may be used, after the latter, for cold feet or cold legs. In marasmus oil rubs improve body nutrition.

The Scotch Rub.—This consists in washing a part of the body with hot water and then rubbing with a towel wet in cold water. It sometimes replaces cold sponging, but its effects are milder and slower.

Salt Rub or Salt Glow.—A small handful of finely ground salt is dampened in salt water at 104°-105° F. (40°-40.5° C.), and with it the patient is rubbed. After this the patient is washed off with a warm-water spray; the water is gradually cooled. A full tub bath may follow or take the place of the spray. A cocoanut-oil rub is then given for 15 minutes.

Ice Rub or Ice Ironing.—Flat pieces of ice, inclosed in gauze, are rubbed over body and limbs. In conjunction with sprinkling it has been advocated in sunstroke.

Alcohol Rub.—This is usually applied as a terminal measure. It enhances the circulation, is a tonic to the skin and, after packs or douches, prepares the skin for contact with the outer air. Only grain alcohol, either pure or slightly diluted, should be used, about four tablespoonfuls being sufficient for an entire body rub.

DOUCHES.—These are useful in treating limited portions of the body. The various forms are chosen according to requirements, and may be short or prolonged, hot or cold, or alternately hot and

cold, and under more or less pressure, i.e., varying from 10 to 35 pounds to the square inch.

Cold applications, continued for one or two minutes, are strongly stimulant in action. The underlying tissues (vascular and lymphatic) are affected in proportion to the pressure used. Without pressure the action is superficial, but may cause reflex stimulation in some regions of the body.

Hot applications reduce the sensibility of the superficial nerves of the skin. They produce local and reflex sedative effects when water is at 90°-100° F. (32.3°-37.8° C.).

Needle Douche or Spray; Circular Douche.—In this form there are usually sixteen "roses" having minute perforations through which the water flows, arranged at different heights upon a circular standard, the upper row being adjusted to give a downward spray, so as to avoid the face and head. A higher pressure may be used than in the douches of larger size. The many fine jets of water striking the skin feel like needles. A preliminary hot-air or electric-light bath is given to induce perspiration. The duration of the douche is usually one or two minutes, beginning at 105° F. (40.6° C.), gradually lowered to 90° F. (32.2° C.), at 20 pounds' pressure.

Cold Douche.—This is a powerful stimulant, and often used after the hot-air bath and circular douche. It is contra-indicated in asthmatic patients. A single stream of water under pressure, through a ¼- or ½- inch nozzle, and at a distance of from 6 to 10 feet from the patient, is used. Cold douches should follow hot applications; alternate heat and cold are also used. Cold douches preceded by warm applications and followed by friction are used against anemia, insomnia, and headaches; acne, chronic constipation, autointoxication, and general malnutrition.

Spinal Douche.—A douche applied to a limited portion of the spine, the water at 45°-60° F. (15.6°-72° C.), and under 20 to 30 pounds' pressure, was used by Charcot in hysteria with good results.

Alternating Hot and Cold Douches (Scotch Douche).—This produces marked excitation. It cannot be applied to the head or the anterior thorax. Satisfactory results are obtained with water at 105° F. (40.6° C.) and 70° F. (21.1° C.); in the

robust the extremes may be 110° and 55° F. (43.3° and 12.8° C.).

Head Douche.—These should be cold or cool, without pressure, and given from a pitcher or dipper; the duration should be only a few seconds. The primary effect produced is a dilatation of the cerebral vessels; if long continued, a secondary contraction and chilling are induced. They are used with the Brand bath or drip sheet, always at a slightly lower temperature and repeated once or twice. They are useful in mental disease (melancholia, hypochondria, etc.). In insomnia, mania, and paresis, the temperature extremes of the water are 80° F. (26.7° C.) and 95° F. (35° C.). In the case of women the full bath or spinal douche is preferable, on account of the difficulty in drying the hair.

Rain Douche.—This is an elevation of the ordinary shower bath. The pressure and temperature are regulated by valves. In brief applications and at moderately low temperatures, a vigorous nerve stimulation and strong circulatory reaction are produced. It is valuable in neurasthenia, hysteria, neuralgia, paresis, disorders of nutrition, and weak circulation (non-organic). The tepid and warm rain douches are sedative in their effects, and are used in hypersensitive neurasthenia and hysteria. Alternating changes in the temperature are useful in anemia, chlorosis, and skin diseases.

Fan Douche.—When the thumb is placed over the nozzle delivering the jet douche, breaking it into a fan-shape stream, it becomes a fan douche. This is used as a terminal measure; it is given cool or cold.

Filiform Douche.—This is a very fine douche, given at high pressure (60 pounds or higher). It acts as a powerful counter-irritant and stimulant. It is useful in sciatica and other neuralgias; it is applied for from one-half to two minutes. The steam douche is a variation, live steam being used.

Perineal Douche.—In this douche the patient sits upon a stool with the center cut out or a circular seat and receives on the perineum a ½-inch jet or spray douche. Low temperatures, 60°-80° F. (15.6°-26.7° C.) are employed. Used in vesical atony, chronic proctitis, sexual depression, psychic impotence, and hemorrhoids. Dura-

tion is from three to ten minutes; the force of the stream should be sufficient to raise the water about 30 to 40 inches.

Aix Douche.—This is a combination of the douche with vigorous massage (*douche-massage*). It is a specialty of Aix-les-Bains.

Affusions.—The patient, nude or covered only with a sheet, lies on a cot protected with a rubber blanket. Basins or pails of very cold water are dashed on him from a height of several feet, alone or with the half-bath or Brand bath. They strongly stimulate and aid in rousing an unconscious patient; they are especially useful in **sunstroke**.

CONTINUOUS BATHS.—The **Warm Full Bath.**—In this the patient, having his head covered with a cloth wet in cold water, lies fully immersed in a large tub nearly full of water at 95°-100° F. (35°-37.8° C.). The room should be warm (80° F.—26.7° C.), and the water should be maintained at its initial heat for from ten to twenty minutes or more. In surgical and skin cases the body is anointed well with mutton suet, lanolin, or petrolatum to protect the skin from peeling or shrivelling. It is used in severe skin eruptions like **pemphigus**, where it relieves pain, reduces fever, and allows the patient to pass safely through the eruptive stage.

Prolonged warm baths are advised for patients with **bed-sores**, **compression myelitis**, **locomotor ataxia**, and **paraplegia** with paralysis of the bladder and bowels, **inoperable cancer** of the urogenital tract, **obstinate sciatica**, **muscular and articular rheumatism**, **chronic meningitis**, **hemiplegic contractures**, and **general hyperesthesia**.

Warm baths of short duration are beneficial in the fevers of infancy and childhood, in **cerebrospinal meningitis**, in **acute mania** and other conditions due to **excited nerves**. Friction is not usually required. A half-hour bath, at 110° F. (43.3° C.) is beneficial in **amenorrhea** and **dysmenorrhea**.

Atheroma and **cardiac diseases** contraindicate the warm bath.

The Hot Bath.—In these baths the water is at 104°-115° F. (40°-46.1° C.). The effects vary according to their temperature and duration, less nerve exhaustion following their use because of less demand upon the heat-producing centers,

and when followed by cold affusions there is a feeling of increased vigor. The patient should then recline for at least half an hour. This is used in cases of **infantile convulsions**, though the hot pack is preferable.

SPECIAL BATHS.—The **Brand Bath.**—This was formerly used extensively in **typhoid fever**. It is still recommended by some observers. The technique submitted is that obtained from Brand himself by Simon Baruch (*Am. Jour. of Physiol. Therap.*, Sept., 1910). When the axillary temperature taken for ten minutes registers 39.5° C. (103° F.), the patient is lifted into a tub two-thirds full of water not below 18° C. (64.4° F.) nor above 20° C. (70° F.) in which he is rubbed gently for fifteen minutes. During the intervals a compress of three folds of old linen wrung out of water at 60° F. and covered with thin flannel is placed over the abdomen and held firmly in place by a thin flannel band covering it completely. This is renewed every hour if warm. The bath is repeated every four hours when the rectal temperature is 103° or over.

The Turkish Bath.—This is cleansing and stimulating. The patient adjusts a loincloth about the pelvis, takes a drink of water and enters a room with dry air at from 110°-130° F. (43.3°-54.4° C.). Perspiration appears in ten or fifteen minutes. The patient is superficially massaged to increase the perspiration, and sometimes a hot foot-bath, hot spray, or hot full bath is given. When perspiring freely the patient enters another room, at 150°-200° F. (65.6°-93.3° C.) for a few minutes. He is then rubbed vigorously with bare hands and then given a soap shampoo, lying on a marble slab. A cold douche, at 60° F. (15.6° C.) is then given or, if perspiration is still rather free, a rain douche, the temperature being reduced in from one to three minutes from 85° F. (29.4° C.) to 75° F. (23.9° C.), or 60° F. (15.6° C.). A cold plunge in water at 60° F. (15.6° C.) follows, and then he reclines until the skin is dry and pulse normal. Finally, an alcohol rub is given, after which he rests.

In **acute pharyngitis** and **suppressed menstruation** the Turkish bath gives relief. It is beneficial in the treatment of **obesity**, **alcoholism**, **diabetes**, **chronic dys-**

pepsia, anemia and chlorosis, and the gout of the obese. Syphilitic, neurasthenics, and insane patients, and certain patients having neuritis and chronic myelitis are improved. In cardiac dilatation, cardiac asthenia, tachycardia, arteriosclerosis, high blood-pressure, pulmonary congestion, chronic bronchitis with emphysema, and exophthalmic goiter; in advanced heart disease and Bright's disease, in cases with a history of apoplexy, and in skin diseases with eruptions its use is contraindicated.

The Russian Bath (Diaphoretic).—In this the patient lies on a marble slab in a small, steam-filled room, being rubbed at intervals to hasten perspiration. The room-temperature is lower than in the Turkish bath, the steam making higher temperatures unbearable. After remaining in this room from ten to twenty minutes he takes a shower of cold water or a plunge in a pool at 60° F. (15.6° C.).

Vapor or Sweating Bath.—In this a blanket on a rubber sheet is placed under the patient, and he is wrapped in a blanket. A cradle covered with a rubber sheet and blanket is placed over him and the cradle-covers are tucked closely around the neck. An ice-cap or cold compress is placed on his head. Steam is allowed to enter gradually through a spout leading from a kettle of boiling water. The duration may be from 30 to 60 minutes, or longer. The patient's temperature, pulse, and respiration should be watched. When the steam is stopped, the patient should be wrapped in a dry blanket and allowed to rest.

Foot-bath.—This entails the use of a small tub or pail of hot water and an additional supply of very hot water. The temperature is therewith gradually raised from 110° F. (43.3° C.) to 115° or 120° F. (46.1° or 48.9° C.). The duration of the bath may be from 10 to 15 minutes; the depth of the water may be 8 or 10 inches. A little mustard may be added. A cold compress should be placed on the head. This bath is beneficial after the initial chill of pneumonia, in sprains of the ankle or foot, bruises, cramps in the legs, etc.

Medicated Baths.—*Alkaline Bath.*—Use 1 ounce (30 Gm.) sodium bicarbonate to every 5 gallons (20 liters) of water.

Pine-needle Bath.—Pine-needle extract, 2 ounces (60 Gm.) to 40 gallons (160 liters).

Sulphur Bath.—Potassium sulphide, 1 ounce (30 Gm.) to 7 gallons (28 liters) hot water.

PACKS.—**Cold Wet Pack.**—A narrow bed and mattress protected with a rubber sheet, and on this a large blanket, a hair pillow covered with rubber cloth and a pillow slip are prepared, and one or two additional blankets, a sheet, four small towels, a hot-water bag, half-filled with hot water not over 120° F. (48.9° C.), a foot-bath with water at 102°-105° F. (38.9°-40.6° C.), a pitcher of ice-water, and a bucket of water for the sheet at 65°-70° F. (18.3°-21.1° C.) are made ready. The patient in a bath robe sits with his feet in the bath of warm water, and with a cold compress on his head. The attendant wrings out the sheet from the cold water and spreads it evenly on the bed. The patient removes all clothing and lies on the wet sheet with arms extended. The sheet on one side is wrapped over the body and limbs; the hands are brought to the sides and the other half of the wet sheet covers in both arms and the lower limbs. The feet are left uncovered by the sheet, and the hot-water bag, covered with a towel, is placed at the soles. The patient is now well covered with the underlying blanket, close adjustment at the neck excluding all air. Another blanket, folded, envelops the entire body. The turban of ice-water is changed when warm.

Hot Wet Pack.—This is done similarly, hot water being used instead of cold. It is followed by a tepid or cool sponging, and is used in anemia, in the sequelæ of scarlet fever, and in catarrh of the air-passages in children. In infantile convulsions it equals the hot bath. In uremia, especially of pregnancy, it is invaluable.

Dry Hot Pack.—Dry, hot blankets are used after the warm douche or hot baths in gout, rheumatism, syphilis, and obesity.

COMPRESSES.—**Cold Compress.**—The material used is linen, eighteen inches wide, covered by several layers of flannel to prevent radiation. The water should be at 50°-60° F. (12.8°-15.6° C.). The linen is partly wrung out, laid evenly over the affected side, and is covered with a flannel binder applied loosely. The compress should be renewed every hour. This is useful in pneumonia, toxemia being reduced, crisis hastened, and pulse improved.

Ice Compresses.—These are best applied in the form of ice-bags.

Hot Compresses (Fomentations).—Well-soaked flannel is used, covered with sufficient layers of dry flannel, and unless very hot, in direct contact with the skin surface, hyperemia is induced and internal congestion relieved. Hot compresses favor suppuration, hasten the absorption of exudates, relieve pain, and loosen up stiffened joints. They are used in rheumatoid arthritis, arthritis deformans with pain and swelling, sprains, bruises, cramps of the extremities, in biliary, renal, and hepatic colic, in affections of the bowels and pelvic viscera, intercostal neuralgia, lumbago, and sciatica.

Fomentations are contraindicated when appendicitis threatens, in peritonitis due to perforation or injury or when idiopathic, and in the onset of pneumonia. In all these cases ice-bags, cold compresses, and similar measures are preferable. W.

WEIL'S DISEASE. See LIVER AND GALL-BLADDER: ACUTE INFECTIOUS JAUNDICE.

WEN. See SKIN, SURGICAL DISEASES OF.

WHOOPIING-COUGH. See PERTUSSIS.

WINTERGREEN. See GAULTHERIA.

WITCHHAZEL. See HAMAMELIS.

WORMS. See PARASITES.

WOUNDS, SEPTIC AND SEPSIS.—By septic wound is meant a lesion in which the tissues have become infected by pathogenic organisms. Sepsis refers to an invasion of the blood by these organisms or their toxins.

PROPHYLAXIS.—The great European war afforded abundant material, unfortunately, for the study of measures which tend most effectively to thwart even the most extreme risks of wound infection, and,

therefore, of general sepsis. As emphasized by Sir A. E. Wright, the clothing and skin of the soldiers are usually in a foul condition. The projectile passing through a zone of filth necessarily carries infection along its path, often far beyond the reach of antiseptics. This results in a primary infection, not only with streptococci, but also with organisms from the feces, particularly gas, tetanus, and colon bacilli. Death, therefore, may result from erysipelas, gangrene, cellulitis, or tetanus. If the wound is open and aerobic conditions prevail, a secondary infection, with other pus organisms, notably the *Bacillus proteus*, may follow. Overshadowing the issue also is the danger of general sepsis in its various forms, with death as a probable result. In no phase of the practical field, therefore, is prophylaxis more important.

Commonly Used Antiseptics.—A striking feature of the first two years of the war, in this connection, was that virtually all the older antiseptic agents were found wanting. Phenol proved to be of low germicidal power, especially in the presence of serum, and, when sufficiently concentrated, damaged the tissues. Peroxide of hydrogen had very little germicidal action in the presence of tissue fluids on account of its rapid decomposition by catalase present in them. Robert Morris, some years ago, pointed out its morbid influence on the processes of repair. Bichloride of mercury rapidly lost much of its antiseptic power in the presence of albuminous fluids and was irritating to the tissues even in very dilute solutions. Silver nitrate proved more valuable than bichloride of mercury, but was also found to be a violent irritant. The coagulation of protein and its irritant properties reduced the value of iodine for use in wounds, notwithstanding its great value as a surface antiseptic. On the whole, the virtues detailed elsewhere under the re-

spective headings of these powerful agents (*q. v.*) did not stand the test of the extraordinary conditions the war evoked, and imposed the necessity of looking elsewhere for efficient agents.

Sodium Hypochlorite or Dakin-Carrel Solution.—Of the various preparations tried this afforded the best results. It was introduced by H. D. Dakin to eliminate the disadvantages of the older antiseptics. As obtained in commerce, however, sodium hypochlorite, though highly germicidal, is extremely irritating to the tissues, owing to the presence of free alkali and free chlorine. Dakin found that boric acid overcame this defect.

The solution was then prepared as follows: 140 grams (4½ ounces) of dry sodium carbonate, or 400 grams (13½ ounces) of the crystallized salt, are dissolved in 10 liters (quarts) of water, and 200 grams (6½ ounces) of calcium chloride of good quality are added. The mixture is shaken and at the end of half an hour the clear liquid is siphoned off from the precipitated calcium carbonate and filtered through cotton. Forty grams (10 drams) of boric acid is then added to the liquid and the solution is ready for use. It is important to add the boric acid after filtration, not before. The solution will not keep more than a week. Dakin then ascertained that the best results were obtained when it was used by continuous irrigation; that it favored the dissolution of necrotic tissue; that it was slightly hemostatic, though not irritating to the wound tissues.

Carrel then took up the question at the Rockefeller Foundation Temporary Hospital at Compiègne, France, in collaboration with Dakin, the aim being to overcome the terrible effects of infection. Indeed, 80 per cent. of all amputations, 75 per cent. of all deaths after the first 24 hours, and 95 per cent. of secondary hemorrhages were due to this factor, and not to the gravity of the wound. Of all antiseptics tried, Dakin's proved the most satisfactory.

The following technique was employed: After the wound had been thoroughly though gently cleansed, foreign bodies and all bits of bone removed, and the bleeding controlled, a loose dressing was applied,

no impermeable substance ever being used. Numerous rubber tubes, perforated with many small holes, were then run down into all recesses of the wound and allowed to project out through the dressings. Dakin's fluid was poured into them every hour at first and less frequently later, with continuous day and night irrigation, proved even better. (See also page 193, this volume). This fluid could be applied for days, or even weeks, without irritating the tissues. It should not be used with alcohol, however, and should not be heated.

The process of healing was carefully watched, and, if normal healing did not ensue, the wound was examined for foreign substances, which might have inadvertently remained, and then irrigated anew. But the removal of muscles or bones not irreparably injured was not practised on the first or second examinations as frequently as had been the case heretofore, and in this way parts were saved which otherwise would have been lost.

When the phenomena indicating infection had subsided and smears showed decreasing numbers of bacteria in the secretions of the wound, and finally their complete disappearance, the wound was closed. This was usually possible from the fourth to the tenth day. The infection having been overcome, conditions were practically the same as in a fresh operative wound, and the tissues healed by primary intention when carefully coaptated.

Strips of adhesive plaster, from 2.5 to 5 cm. wide, were applied perpendicularly to the wound to bring the tissues together (or clips can be used); no suturing was done unless circumstances compelled it. This early closing of wounds got the patients up much earlier, and this in turn aided in warding off stiff joints and atrophy of the muscles.

While the original Dakin solution contains 0.5 to 0.6 per cent. of sodium hypochlorite, an improved solution subsequently prepared by Dautresne contains 0.45 to 0.5 per cent. and is free of boric acid.

Dautresne's technique has been described by Dakin as follows. (Keen: "Treatment of War Wounds," 1917): "Two hundred Gm. (6½ ounces) of good bleaching pow-

der are put in 12-liter (quart) bottles with 5 liters (quarts) of tap-water. The solution is shaken vigorously and allowed to stand for at least 6 hours. In another vessel 100 Gm. (3½ ounces) of dry sodium carbonate and 80 Gm. (2½ ounces) of sodium bicarbonate are dissolved in 5 liters (quarts) of cold water and then added to the bleaching powder mixture. The whole is shaken vigorously for a few minutes, and the precipitate allowed to settle. After half an hour the clear solution is siphoned out and filtered through paper. With the most brands of American bleaching powder it is better to use 90 Gm. (3 ounces) of each salt. The solution must invariably be tested for neutrality by adding a pinch of solid phenolphthalein to a little of the solution. If the solution should react alkaline, 1 of 3 methods must be employed to correct it, otherwise skin irritation will surely result: (a) Pass carbon dioxide gas into the solution until a sample shows no alkalinity. (b) Reduce the proportion of sodium carbonate and increase the bicarbonate. (c) Add boric acid. The carbonate-bicarbonate mixture possesses greater stability and can be kept for several weeks without much deterioration."

Following procedure described as a rapid method of preparing **Carrel-Dakin solution**. The materials: A solution of chlorinated soda containing 2.8 to 2.9 per cent. of available chlorine; one of sodium bicarbonate of about 5 per cent. strength; and some phenolphthalein powder. One part of chlorinated soda solution is diluted with 5 of water, and to this 25 c.c. (6¼ drams) of the bicarbonate solution is added for each liter (quart). The whole is well mixed and 20 c.c. (5 drams) removed and tested with a little phenolphthalein. If there is no red color the solution is ready for use. If red appears, 10 to 20 c.c. (2½ to 5 drams) more of bicarbonate solution is added, and the test repeated until the red does not appear.

The chlorinated soda solution is readily obtainable, and keeps well. F. Rosengarten. (*Jour. Amer. Med. Assoc.*, Sept. 29, 1917).

Describing **Carrel's method**, the writer notes that tubes have been found most practical to carry the liquid to the wound. They are lengths of rubber tubing of 4 millimeters interior diameter. 30 to 40 millimeters in length. They are closed at one end by tying with strong linen thread, and perforated from the same end over a length of 5, 10, 15 and 20 centimeters by means of a punch, making holes ½ millimeter in diameter, perforating both walls 1 centimeter apart. The tubes are so arranged in the wound that the liquid may readily spread over the whole surface. They are not applied over gauze, but directly to the wound, and compresses soaked in Dakin's solution are laid over them. Gravity plays a considerable part in distribution of the liquid. Covered tubes with Turkish toweling are used in cases of superficial wounds, vertical setons and wounds of the posterior aspect of the limbs. In superficial wounds instillations may be made through a looped perforated tube attached to the skin above by adhesive plaster. On inclined surfaces the tubes should be applied to the upper portion of the wound. All tubes are connected by glass distributing tubes with the irrigating flask. The latter usually holds a liter and its inferior orifice has a diameter of 7 millimeters. It is hung at a height of from 60 to 100 centimeters above the bed, according to the number of tubes in the wound.

Every 2 hours the nurse releases the pinch cock for a few seconds and gives to the wound from 30 to 100 c.c. (1 to 3½ ounces) of solution. The total quantity per diem varies from 250 to 1200 c.c. (8½ to 40 ounces). At the daily dressings the skin is protected by squares of gauze soaked in yellow vaseline. A pad of absorbent and non-absorbent cotton covers the entire dressing, the absorbent layer being placed next to the wound.

Smears are taken every 2 days from the most infected parts of the wound

the instillation being stopped 2 hours before. They are stained by carbolfuchsin and the bacteria counted. With a Bausch and Lomb microscope the No. 10 ocular and 1.9 millimeter objective are used. The average number of bacteria in a field is then estimated and charted. When only 1 bacterium is found in 5 to 10 fields surgical asepsis is obtained and the wound can be sutured with safety. Wounds of the soft parts, with sterilization begun in a few hours, can thus be closed after 2 days. In fractures it is preferable to wait until the wound has been surgically sterile for 4 or 5 days. Where sterilization has been begun after a period of supuration, one should find the secretions sterile for a week at least before suturing. G. Loewy (N. Y. Med. Jour., Oct. 27, 1917).

The skin surrounding a wound treated with Dakin's solution should be protected with vaseline, otherwise painful and persistent cutaneous irritation sometimes ensues. Care must also be taken that the solution is of precisely correct strength, too strong a solution proving more irritating, while a solution weaker than 0.45 per cent. is insufficiently germicidal. One of the main objects in the treatment is to keep the solution constantly in contact with all the wound surfaces. For this reason dependent drainage is avoided. Frequent renewal of the solution in contact with the wound—every 2 hours—is necessary because the solution, in the presence of the wound exudates, rapidly loses its chlorine content.

The improvement in wounds treated by the Carrel method is due rather to the proteolytic action of the hypochlorites on mortified tissues than to any sterilizing action. The Dakin solution is only feebly germicidal. The more proteins it dissolves, the more attenuated its antiseptic action. Fiessinger and Clogne (Rev. de chir., Sept.-Oct., 1917).

In applying the Carrel-Dakin method to wounds in private practice, care should be taken that the solution is non-irritating. If the pa-

tient complains of continuous burning in or about the wound the solution has usually become alkaline, and should be neutralized with a solution of boric acid. As it breaks down readily, it should be kept in well corked dark bottles. A preparation more than a week old should be discarded. The bacteriological status of the wound should be determined every few days. Good results are obtained with the Carrel-Dakin outfits on the market. Gauze should not be employed. The tubes should not be allowed to remain in any one position more than twenty-four hours. The irrigations should be made at two-hour intervals and enough used to bathe the parts thoroughly. The dressing should not become dry between treatments, nor should the wounded part be allowed to lie in a wet bed. P. J. Reel (Ohio St. Med. Jour., Jan., 1918).

The Carrel method has given good results in extensive superficial wounds. In fractures the results differ according to the bones involved. They are good in the case of the humerus or a single bone of the forearm; slower for both bones of the forearm or leg. Complete sterilization is not obtained in fractures of the femur. The method fails in osteitis and osteomyelitis and subsequent sinuses; in joint fractures, where it does not obviate resection, and in purulent pleurisy. Careful hemostasis must be established at once after the operation to avoid secondary hemorrhage, which Dakin's fluid favors by dissolving blood-clots. The usual drainage at the lowest point should not be omitted. A. Rendu (Lyon chir., July-Aug., 1918).

Apart from the Carrel-Dakin solution and procedure a large variety of other antiseptic agents came into use during the European war. A number of these have now passed into oblivion. The remainder, such as dichloramine-T, flavine, and sunlight, will be referred to under TREATMENT.

The writer urges the value of dusting war wounds thickly with a dry powder consisting of **calcium hypochlorite** and **boric acid** in the proportion of 1:10. This prophylactic treatment, particularly useful when the wounded are coming in in large numbers, is renewed the next day, if there is delay in getting the wounded to the hospital. It has a powerful sterilizing action and seems to ward off gas gangrene. Vincent (*Presse méd.*, Mar. 29, 1917).

Starch iodide is recommended by the writer in wounds of soft parts due to abrasion, unassociated with sinuses or deep, inaccessible tracts. In deep wounds success was secured by irrigations of starch iodide after the Carrel method. The solution consists of soluble starch, 25 Gm. (4¼ drams); boiling water, 1 liter (quart), and 1:1000 iodine-iodide solution, 50 c.c. (1½ ounces). This fluid contains iodine in extreme subdivision, and seems to possess antiseptic power of the same order as Dakin's solution. It is not irritating to the skin and has no deleterious action on clothing. A. Lumière (*Presse méd.*, Sept. 20, 1917).

In minor wounds, the writer first covers the injury with cotton or gauze wet with 1:2000 **mercury cyanide** solution. Then, under strict aseptic precautions, the surrounding skin is scrubbed with sterile water and liquid soap, hair shaved off, foreign bodies and visible dirt removed, bleeding vessels ligated, shreds of flesh cut away, the wound irrigated with hot, sterile water and sutured, drained if necessary, and covered with sterile cotton and bandages. If near a joint, a splint is applied. A dressing wet with **Dakin's solution** is kept on for a few days until all danger of infection is past. A. W. Colcord (*Internat. Jour. of Surg.*, 30, 312, 1917).

Iodine promotes the healing over after the wound cavity has filled with granulations. Plaster is swabbed on the adhesive side with a 10 per cent. tincture of iodine and when dry, cut

into narrow strips which are applied to the edge of the wound, the strip fitting for 1 millimeter on the epithelial margin and the other 3 or 4 mm. on the granulation tissue. Often the epithelium heals over as promptly as if Thiersch grafts had been applied. Taddei (*Riforma med.*, Mar. 30, 1918).

In recent wounds, before active infection appears, no mode of disinfection gives as good results as **hot air**. It is not to be substituted for the customary excision of dead or injured tissue, but acts well in place of any antiseptic liquid or powder. In a buttock wound contraindicating complete excision, recovery was obtained by carbonization with **oxygen** heated to 1000° C. under pressure. In long-standing obstinate wounds, air heated to 55° or 60° C. proved useful both in military and civil practice. M. Vignat (*Bull. de l'Acad. de méd.*, Mar. 4, 1919).

Wound Excision and Primary Suture.—

The foremost surgical development of the war as regards wound treatment was probably the general recognition of the principle of complete wound trimming or excision (*débridement*), which introduced the possibility of effecting immediate (primary) closure of wounds even when presumably infected. Through the Carrel-Dakin method, reasonably prompt secondary suture of wounds already in a manifest state of infection was rendered feasible, but in wounds coming for treatment early—within eight or ten hours after injury—more rapid results than are afforded by the Carrel method are desirable, and this desideratum has to a certain extent been supplied by the procedure of wound excision, which seems destined to pass definitely from military into civil practice for the treatment of severe, presumably infected wounds. As John T. Bottomley stated (1919), it is logical to assume that as *débridement* comes more into vogue, the need of the Carrel-Dakin method will be less urgent.

At the time of the beginning of stable trench warfare after the first battle of the Marne, the results from expectant treatment of wounds—nearly all primarily in-

fect—became extremely unfavorable, active suppuration, secondary hemorrhage, gangrene, septicemia, and lingering illness being commonly observed. Early in 1915 a number of surgeons were insisting not only on prompt wide incision and drainage of wounds, but also on immediate removal of all avascular tissue and all structures manifestly dead or about to undergo necrosis. By the middle of 1915, both antiseptic treatments, such as that of Dakin-Carrel, and the principle of early suture after complete wound cleansing, were in process of practical trial. In France, Lemaitre, Tissier, Duval, and Depage, and in England, Gray, were among those who compelled recognition of the principles of *débridement* and *primary suture*. At first tried only in fresh, comparatively clean wounds—especially in wounds of the knee-joint, scalp and brain, lungs, and abdominal wall—the field for primary suture was gradually extended to more dubious cases.

The technique of wound excision as commonly performed is as follows:

(1) Incision. This is usually made either parallel to the muscle fibers or to the large vessels and nerves; or it may be differently placed to open up the track of the projectile widely; or it may actually connect the wounds of entrance and exit. (2) The track of the projectile is followed and all diverticula opened and explored. (3) Foreign bodies, clothing, projectiles, and loose fragments of bone or skin are removed, together with all tissues already dead or avascular and destined to necrosis. Important vessels and nerves *must* be saved. (4) Hemostasis is completed, with ligation of all visible bleeding points, followed by gauze pack for a few minutes and then by fixation of the bacteria in the wound by tincture of iodine. (5) Repair of the structures is made by suture.

If because of poor general condition or other material circumstances, excision is not completed, one must effect their removal at a subsequent dressing to avoid spontaneous elimination by necrosis and consequent contamination of the wound.

Primary suture can be practised only when proper surgical surroundings make aseptic conditions possible. Advanced infection and impaired local circulation are absolute contraindications to it. R. T. Vaughan (Surg., Gynec. and Obstet., Apr., 1919).

Where immediate suture was deemed inadvisable, *delayed primary suture* was frequently carried out two to four days after the initial excision treatment, if the wound seemed in good condition. Correct results from this procedure were found to be more easily obtained with the aid of bacteriologic study of the wound secretions. Carrel treatment may or may not be applied during the interval between excision and suture. The so-called *secondary suture* consists in closing the granulating wound later than four days after the excision, after removal of the epithelial margin and neighboring skin or a complete excision of the scar tissue. Where the wound is in a sufficiently unfavorable condition to make delayed primary suture inadvisable, the next object in view is to carry out secondary closure when the wound has become practically sterile and contains no streptococci.

The principle of primary suture is definitely established, but opinions as to the legitimate field for it remain at variance. Clean wounds in civil practice are obviously comprised in this field. Of the army surgeons, some remain adherents of the Carrel procedure, after primary excision, for practically all types of war wounds.

[W. Wayne Bahcock (1919) has described a special method for the immediate sterilization and closure of *chronic* infected wounds of bones and soft tissues (see under TREATMENT). Ed.]

Where primary suture is impracticable, the writer attempts *secondary suture*. After careful removal of dead tissues, the wound is treated by continuous or intermittent irrigation or with a simple wet dressing of 12.5 per cent. magnesium chloride and 0.125 per cent. ammonium chloride. This is preferable to Dakin's fluid, which at times burns the tissues. Complete arrest of suppuration and

descent of the temperature generally occur in two or three days. The wound is then cleansed with tepid magnesium chloride solution, and secondary closure effected with sutures or adhesive strips. Heliotherapy accelerates repair. G. Pothérat (*Presse méd.*, Dec. 20, 1917).

Report of experience with **primary suture** in 2537 cases. It is not necessary to excise any more tissue for primary suture than with any other method. Curved scissors are preferable to the knife. The wound is next dried with gauze, the tissues swabbed freely with 5 per cent. tincture of iodine, and any excess wiped up. Iodine is not needed for small wounds with healthy tissues which do not require excision, nor when the devitalized tissues are removed *en bloc*. The iodine somewhat retards healing and delays removal of sutures to the twelfth or thirteenth day, but it offers the advantage that **delayed primary suture** can be postponed till the eighth or ninth day or even longer. The *iodine fixation* renders harmless the germs sown on the surface of the wounds during the operation. In the last series of 1891 wounds, primary suture was applied in 79 per cent. and proved successful in all but 0.84 per cent. In the complete failures the streptococcus was always found, but even the streptococcus does not inevitably doom the suture to failure. R. Lemaître (*Lyon chir.*, Jan.-Feb., 1918).

Every war wound free of the streptococcus should be sutured. Fulminating putrid infection always results from anaërobes plus the streptococcus. At 37° C. its cultures are characteristic in five or six hours. Swabs should be taken from all portions of the wound at the fourteenth to the eighteenth hour and inoculated in bouillon agar slants with lactose litmus and in Veillon agar. Streptococci were found in but 10 or 15 per cent. of fresh cases, with anaërobes in 6 or 8 per cent. But by the time unsutured wounds reach the hospitals at the rear, fully 80 per

cent. show streptococci. No antiseptic should be used except possibly ether and iodoform-ether solution for bone lesions. G. Gross (*Paris méd.*, Feb. 23, 1918).

Regular healing takes place only where all adhesion of dressings is avoided. This is easily secured by covering the wound with a layer of tulle of 2 millimeter mesh, impregnated with sterile vaseline. Simple washing of wounds with **normal saline solution**, i.e., aseptic treatment, results in more rapid progress than occurs with antiseptic ether solution, the daily rate of healing rising to 1.2 or 1.3 mm. At times, however, healing under such treatment is suddenly checked by bacterial contamination. The best plan is to use dressings of **starch iodide**, healing being thus accelerated to over 1.6 mm. a day. A. Lumière (*Bull. de l'Acad. de méd.*, Mar. 12, 1918).

The writer's system of "reinforced prophylaxis" for wounds comprises **primary excision** plus deep disinfection by infiltration of the tissues with solutions of **quinine derivatives** by means of the hypodermic syringe. **Isoethylhydrocupreine**, the quinine derivative having the greatest destructive action on the streptococcus and staphylococcus, is used in 1:10,000 solution in normal saline solution, filtered through cotton and sterilized. **Novocaine** or **adrenalin** may be added if required. Joint wounds respond most favorably to the solution, which is injected into the joint as well as the surrounding tissues. R. Klapp (*Münch. med. Woch.*, May 7, 1918).

Sloughs from foul wounds do not require chemical solvents for their removal, but can be eliminated by tryptic ferment set free from disintegrated leucocytes. Liberation of this ferment is greatly accelerated by breaking down the leucocytes in the discharges with **hypertonic saline solution** (5 to 10 per cent.). Nothing prevents a wound surface washed quite clean of albuminous matter from being sterilized by a single ap-

plication of antiseptics. A. E. Wright, Fleming and Colebrook (Lancet, June 15, 1918).

Primary suture is feasible even twelve hours after injury when the wound seems slightly if at all infected. In 32 cases, the writer operated and sutured between the thirty-fifth and forty-eighth hours in 12; on the third day in 7, and from the fourth to the eleventh day in 13. In only 3 did reopening of the wound become necessary. In all the others the scar was linear and soft as in the most successful early suture cases. Chaliar (Progrès méd., July 6, 1918).

No attempt should be made to excise a wound when the infecting organisms have already invaded the tissues, as this does not hasten recovery and materially increases the risk of septicemia. The operation should then be limited to free exposure of the entire surface, including all recesses. Comparison of several methods: Carrel-Dakin with early operation, 77.5 per cent. closed by suture; without early operation, 53.5 per cent.; dichloramine-T in eucalyptol, 43 per cent.; flavine, 22 per cent.; hypertonic saline, 12 per cent. Early excision with primary suture is the only method comparing favorably with the Carrel-Dakin procedure. Dichloramine-T in eucalyptol gives very fair results, but epithelialization is somewhat slow, with irregular scar tissue. J. T. Morrison, Hartley and E. F. Bashford (Lancet, Aug. 24, 1918).

In the first stage of wound healing destruction of germs is imperative, but when these are once conquered, disinfectants serve only to injure the delicate tissues forming during repair.

A simple dry absorbent dressing on a sterile wound leads to healing a little more rapidly than the Dakin method.

Systematic exposure to sunlight, however, will greatly shorten the period of healing, *e.g.*, by as much as two weeks. Tuffier and Desmarres (Jour. de chir., Dec., 1918).

In Evacuation Hospital No. 1, in France, between 500 and 600 battle casualties were received in 8 weeks, including mostly the more severe wounds. Of these, 206 were closed immediately; 93.5 per cent. of them healed without a drop of pus or a particle of infection. A number of other cases, forming a second type, were closed when clean and sterile by delayed primary suture; 100 per cent. healed without any infection. The third group comprised those known to be infected and in which the Carrel-Dakin method was used; 85 per cent. healed without suppuration. These results convey a good idea of what can be done under favorable conditions by the newer treatment of battle casualties. Brewer (N. Y. Med. Jour., Feb. 8, 1919).

GENERAL INFECTIONS; SEPSIS.—These conditions, popularly known as "blood poisoning," are due to the invasion of the blood by bacteria or their toxins from the seat of injury. Three forms of general infection have been identified: toxemia, septicemia, and pyemia.

Toxemia or Sappremia.—These terms are applied to a general disorder due to the penetration in the blood of toxins only from a septic focus, a gangrenous or sloughing area, a putrefying blood-clot, a placental remnant, etc., containing pyogenic organisms. The first symptom is usually a chill or several of them, soon followed by a temperature ranging from 100° to 104° F. (37.8° to 40° C.) and irregular in type. The skin is dry and hot; there is headache, nausea, and vomiting, the tongue being dry. These phenomena may appear rather suddenly, *i.e.*, within 24 hours, when the outflow of toxin into the blood by way of the lymphatics is copious, or when a virulent infection of a previously

clean wound develops rapidly. The pulse is usually rapid, but full at first, and the respiration somewhat hurried. These phenomena subside promptly when local treatment of the wound completely removes the source of intoxication.

If the intoxication is allowed to proceed the erstwhile febrile symptoms are attended by increasing weakness, which may proceed to extreme prostration, with jactitation, tremor and delirium, most marked at night. The disorder then assumes the typhoid type, the tongue becoming dry and brown, the lips studded with sordes, the skin even showing petechial hemorrhages, at times, and more or less jaundice. Diarrhea increases in intensity until the stools are passed unconsciously. The urine, which at first was scanty and high-colored, may then be found to contain albumin, hyaline casts, etc., and also be voided unconsciously. As the morbid process progresses, the pulse becomes weak, rapid, and irregular, the temperature subnormal, and coma supervenes, with death on the fourth or fifth day of the febrile process, unless the course taken be truly typhoid in character, when life is somewhat prolonged, death occurring from exhaustion.

Septicemia.—In this condition, due to the presence of bacilli and their toxins in the blood and tissues from the focus of infection—even though this be very small, the symptoms develop less rapidly than in toxemia. They consist of chills, sometimes persistent, fever, anorexia, headache, vomiting, diarrhea, great prostration, mental torpor, and the general typhoid state observed in toxemia.

The fever increases suddenly, the

temperature rising to 105° F. (41.8° C.) or more, when a period of danger is reached. In rare cases, however, fever is absent, and, when the abdomen is the seat of the injury (gunshot wounds, hernia, etc.), the temperature may even be subnormal. The pulse may be strong and rapid at first, but it gradually fails in power until it becomes easily compressible and weak, though rapid. After abdominal lesions the pulse may remain extremely rapid, while the temperature is subnormal. When acute peritoneal septicemia is present serious symptoms develop within 12 hours after the injury, and death may occur within 36 hours. Lesions found after death in such cases, according to Hartmann, are dilatation of the intestines and fine arborescent vascularity of the peritoneal coat.

Diarrhea is frequently observed, but it is seldom as violent as in cases in which the general toxemia is due to the ingestion of toxic foods. It is often protective, in that it aids in the elimination of pathogenic substances, bacterial and organic. Vomiting also occurs, but is rarely severe. The spleen is enlarged in most cases. The lymphatic glands may also show a marked tendency to become infiltrated and enlarged. The urine usually shows considerable albumin and casts.

The blood undergoes rapid deterioration, owing to the bacteremia. As a result, the skin becomes pale and yellowish, and shows a punctate eruption—minute areas of cutaneous hemorrhage—sufficiently like that of scarlatina to suggest the presence of the latter disease. Other cutaneous manifestations may also suggest such diseases as roseola, herpes, superficial

edema, etc. At first the skin is hot, dry, and rough; gradually it becomes doughy, bathed in perspiration, and often cold and clammy.

In the later stages, complications may occur. Endocarditis may develop very insidiously, being sometimes far advanced when discovered, although the physical signs are less marked than is usually the case. Gradually the sallow hue of the skin deepens, the mental torpor lapses into stupor, and dulling of the senses becomes perceptible in every way. The tongue becomes dry and thickly furred; the urine, at first scanty, becomes concentrated, and sometimes has to be drawn with the catheter. Delirium is replaced by coma, soon followed by death.

The local manifestations vary; indeed, none may appear. This is especially the case when the disease runs a very acute course. On the other hand, a severe local inflammatory process may develop, accompanied by sloughing and rapidly spreading gangrene. This may be observed in connection with slight injuries, such as those to which surgeons are exposed. In such cases the wounded finger becomes inflamed and painful, red streaks appear on the arm, and the lymphatic glands of the member swell. This is well shown in the annexed illustration.

In accidents involving crushing, general septicemia may follow contamination from the dead tissues, traumatic gangrene with putrefactive inflammation of the neighboring uninjured tissues ensuing. Moist gangrene, the rapidly spreading gangrene (*gangrène foudroyante*, with evolution of gas), may thus act as foci which rapidly bring on death.

Many such cases have been witnessed in the great European war. There is great swelling, with local emphysema with crackling sounds, the mass giving off a very foul odor. Such tissue becomes totally decomposed if the patient lives long enough.

Some cases, as previously stated, run their course without fever; others progress in the usual way and then cease,—the abortive form,—even after the temperature has approximated 103° F. (38.2° C.). Such cases are not rare.

Blood-cultures in 50 cases of septicemia showed 57 per cent. were positive, the streptococcus being the prevailing organism. Of 23 patients with a positive blood-culture, 74 per cent. died and 26 per cent. recovered. Of 17 patients with a negative blood-culture, 35 per cent. died and 65 per cent. recovered. Ordinarily in this series a low leucocyte count indicated a bad prognosis. The differential count is of the greatest importance. When the polymorphonuclears approach 90 per cent., particularly when the count is low, the prognosis is grave. Abderhalden (Amer. Assoc. of Immunologists; Jour. Amer. Med. Assoc., July 15, 1916).

Pyemia.—This condition, characterized by the formation of multiple metastatic abscesses in various parts of the body, including the endocardium, joints, etc., is due to the absorption of pyogenic organisms, and, in some instances, of the pneumococcus, the gonococcus, the colon, and typhoid bacilli.

The initial symptoms, a chill more or less marked, slight fever, increased sensitiveness of the wound, usually come on a week or ten days after the injury was received: i.e., when supuration has been fully established.



Pyogenic Infection of Lymphatic Gland.

After this first chill, a period of quiescence occurs of perhaps an entire day. As a rule, another chill occurs the second day, followed by another on the third, and so on, until the chill is observed to be irregularly periodical or intermittent: a characteristic manifestation of pyemia. The same irregular intermittence is observable in the temperature-curve, which, after marked elevation,—105° F. (40.6° C.), suddenly falls to normal or below, remaining there until the next exacerbation. The intermissions vary in length—sufficiently long sometimes to suggest recovery. Suddenly another occurs, and another period of high temperature supervenes with sweating. The pulse does not follow the temperature; though its rapidity is increased when there is pyrexia, it is never normal as long as pyemic infection is present. The constitutional symptoms, which correspond with those observed in septicemia, may be very severe.

The second period is that during which metastatic abscesses are formed. The lungs, the spleen, the liver, the kidneys, and the joints are the sites of predilection for these abscesses, the first two organs especially. A sharp pain in the side with dyspnea—the attending signs roughly suggesting pleurisy, hemoptysis, etc.—indicate that the lung has become the seat of the abscess, with perhaps septic effusion into the pleura. If the liver be invaded, jaundice, a common symptom in pyemia, becomes marked, and the physical signs indicate hepatic involvement. Hematuria, the presence of many casts and much albumin in the urine, points to pyemic nephritis. The brain may also be the seat of

abscess, and show signs corresponding with the region involved. The joints are not infrequently the seat of abscesses, and the parotid gland also.

The general symptoms are characteristic, but unlike those of septicemia. The mental condition, unless a brain-abscess develop, is totally different; instead of apathy, there is usually clear perception of suffering, which may become quite severe through the involvement of nerves and joints in the inflammatory process. The skin is usually dark or yellowish and erythematous, and sometimes pustular eruptions may greatly increase the discomfort. The tongue is thickly furred. Marked weakness, emaciation, and exhaustion are the rule, especially in cases of long duration. In the later stages delirium may appear, especially in acute cases, followed by coma.

ETIOLOGY AND PATHOLOGY.—Toxemia or Sapremia.—The morbid process may be initiated from an area of putrefaction or from lesions in any part of the body, the surface, the viscera, sinuses, uterus, etc. The poisons elaborated by the bacteria *in situ*, and which penetrate the blood-stream, are poisonous ptomaines, toxins, etc., the quantity of which determines the severity of the case. The poison—that contained in a drop of blood, for instance—does not communicate toxemia to another subject unless sufficient quantities penetrate the blood of the latter. Toxemia is apt to occur when putrid fluid, blood-clots, etc., are retained in a wound, a joint, amputation flaps, etc., by pressure. Briefly, toxemia, in the surgical sense, means an ill-drained wound. If its cause is not, or cannot, be removed, the case as-

sumes the pathological type of septicemia, from which it can hardly be distinguished *post mortem*. There is marked congestion of all the viscera, including the brain, and also hemolysis.

Septicemia, Sepsis, Septic Infection.—Any wound, no matter how diminutive, may become the starting point of this disease. Hence its comparative frequency among surgeons who, through a scratch, a slight abrasion, or a post-mortem wound, due to a slight prick of the scalpel used, etc., introduce the pathogenic organism beneath the protective integument. No wound may be discovered; the focus of infection may then be a middle-ear disease, tonsillar suppurations or infected crypts, dental caries, pyorrhea alveolaris, suppurative appendicitis, etc. The bacteria, once in the blood, multiply therein and produce continually increasing quantities of toxins. While, as we have seen, a drop of blood in toxemia will not communicate the disease, the same procedure with the blood will, in septicemia, do so, because it introduces bacteria which proceed at once to multiply, reaching the blood by way of the lymphatics. Hence the swelling of these glands, due to the accumulation therein of defensive phagocytes.

Staphylococci, streptococci, pneumococci and colon bacilli are the chief pathogenic organisms. Being soluble, the bacterial products are carried to all parts of the body, unless they have a special affinity for cells, as the tetanotoxin has for the nervous system, the typhoid toxin for endothelial cells, etc. The blood loses its coagulating power; the red cells are destroyed in large quantities and de-

composition begins soon after death. Hemorrhagic areas may occur in the skin and internal organs—to such a degree, at times, as to have warranted the term *hemorrhagic septicemia*. Cloudy swelling is found in practically all organs, the spleen being more or less swollen, though at times greatly softened.

Pyemia.—This disorder is brought about mainly by the passage, from the infected area to the blood, of clots either infected with pyogenic bacteria or saturated with the toxins of these organisms. Pyemia may also be caused in the absence of a wound, such as that attending middle-ear disease. The pathogenic thrombi tend to break up in fragments which, on reaching vessels whose lumina are too small for them, cause obstruction and secondary metastatic or secondary abscesses. The lungs, heart, liver, kidneys, spleen, and the brain are the organs most frequently affected in this manner. These abscesses do not differ from those witnessed in the peripheral tissues, being composed of a central mass of pathogenic organisms, a layer of necrotic tissues, another of leucocytes and the granulation tissue, which separates it from the surrounding normal structures. In the liver the abscesses may be multiple, and are due, in most instances, to appendicitis.

PROGNOSIS.—The prognosis in all forms of sepsis depends greatly upon the powers of resistance of the patient. In toxemia and septicemia the prognosis is favorable both in surgical and obstetrical cases when the focus of infection can be adequately treated early. The time elapsed before this is done greatly

influences the result. The kind of micro-organism present influences materially the prognosis. It is relatively favorable when staphylococci predominate, less favorable if pneumococci are found, and least favorable still if streptococci are present, and also in mixed infection. The bacteriological examination of the blood points to the source of infection. Thus, if we find pneumococci, the respiratory tract is to be looked upon as its source; if the bacterium coli, the intestines, biliary passages, or a cystitis, etc.

When the source of infection—a large septic mass or an infecting surface, etc.—can be reached and judiciously treated, the chances are greatly improved and the symptoms sometimes clear up immediately. This is especially the case in sapremia; but, it is always difficult to ascertain whether we are dealing with this condition or with septicemia, the information obtainable on this score being rather scant.

The rapidity of the course affords some idea of the chances the patient has, and the prognosis may be said to be favorable if the symptoms show but slow aggravation. The rapid forms of septicemia are usually mortal. Important is the fact, already stated, that cases of "abortive" septicemia are often met with, the symptoms receding after a short period of progress. In septicemia occurring as a complication of celiotomy, the chances of recovery are slight.

The duration of pyemia varies greatly; it may last from a week to several months. The prognosis of the disease is unfavorable, however. When the intervals between the chills are short and the metastases

are numerous or involve important organs, the likelihood of an early fatal issue is great. The disease is often linked with septicemia, the manifestations of both forms being mingled, and the progress of the case toward a fatal ending is correspondingly hastened. Erysipelas, which may occur as an accompaniment of pyemia, also reduces the slight chances of recovery. In the form of pyemia attending gonorrhea the morbid processes caused by the gonococcus do not vary greatly from those caused by pyogenic bacteria.

TREATMENT.—Whether the surgeon be dealing with a simple or a severe wound, as soon as fever attends an injury or an operation, nowadays, suspicion is immediately aroused that a septic condition of the exposed surface has appeared.

Local Measures.—The sooner the wound and any accessible secondary abscess is opened, drained, and rendered absolutely aseptic, an infective placenta removed, etc., the better. This is probably best effected by the sodium hypochlorite solution of Dakin and Carrel, described on page 816. Or, a bichloride solution, 1 to 1000, may be used after carefully clearing of any discharge or blood that may be present. In injuries of the extremity, the latter may be left in a bath of sodium borate, 20 grains (1.3 Gm.) to the ounce (30 Gm.), for several hours, if need be, after clearing and disinfecting the wound.

Hydrogen dioxide, widely used in the treatment of infected wounds, dissolves catgut and may cause repetition of hemorrhage, especially if the ligature has been placed in a section of vessel that has suffered contusion. Hydrogen dioxide should therefore not be chosen where vessels have

been ligated with catgut; silk should be used instead of a ligature. E. Delorme (*Presse méd.*, Oct. 8, 1914).

Good results obtained in treating desperate cases of infected railway wounds by 4-hourly irrigation with hot peroxide solution (2 ounces—60 c.c.—to the liter—quart) followed instantly by hot phenol lotion ($\frac{1}{2}$ ounce—15 c.c.—to the liter—quart), and the application of hot bichloride of mercury fomentations (wrung dry). A septic cavity or cavities should be converted into 1 large open sore. When feasible, submersion in warm peroxide lotion once or twice daily is a useful adjunct. O'Connor (*Annals of Surg.*, Apr., 1917).

Lacerated industrial wounds heal rapidly when treated as follows: The surrounding skin is cleaned with gasoline and painted with tincture of iodine, full strength. Paraffin wax (see BURNS) is immediately applied to the wound, which is dressed daily for the first few days, but without touching the wound proper. An electric blower is used as a drier. The writer calls the procedure the "serum-retaining dressing." It is a rapid healer. Excessive granulations and sluggish wounds never occur. F. R. Williams (*Boston Med. and Surg. Jour.*, Apr. 4, 1918).

Stitches should be removed in order to reach every sinus that may serve as a *nidus* for infectious agents. When a cavity cannot be reached conveniently, a syringe may be employed to wash it out. The safest method is to irrigate the wound with the sodium hypochlorite solution referred to above. These measures are sufficient, as a rule, to arrest an uncomplicated *toxemia*, since the focus which supplies the toxins is eliminated.

The artificial nutrient fluids, such as Ringer's and Locke's, afford the best conditions for repair of wounds. Schiassi's serum is especially useful,

as it contains calcium and potassium to strengthen the cells, sodium to combat acidosis, and sugar as a tonic and nutrient. The formula is 6.5 Gm. (100 grains) sodium chloride; 0.3 Gm. (5 grains) potassium chloride; 1 Gm. (15 grains) fused calcium chloride; 0.5 Gm. ($7\frac{1}{2}$ grains) sodium bicarbonate; 1.5 Gm. (23 grains) glucose, and 1000 Gm. (1 quart) distilled water. Soubeyran (*Paris méd.*, Nov. 27, 1915).

For suppurating wounds the writer recommends the following antiseptic and healing dressing: Camphor, 5 Gm. ($1\frac{1}{4}$ drams); balsam of Peru, 10 Gm. (2 $\frac{1}{2}$ drams); gomenol, 25 Gm. (6 $\frac{1}{4}$ drams); ether and liquid petrolatum or almond oil, of each 500 c.c. (1 pint). This is highly diffusible and prevents adhesion of dressings. Healing is accelerated. G. Duchesne (*Bull. de l'Acad. de méd.*, Apr. 3, 1917).

For drainage all that is necessary is to put something into the tissues which will keep a passage open, without leaving an open drain. A soft piece of folded rubber in an appendix abscess will allow pus to come away but will not leave an open drain by which secondary infection can gain entrance. The two main principles of civil surgery taught by the war are, early and complete operation, and that secondary or mixed infection is worse than primary infection. Hathaway (*Brit. Med. Jour.*, June 29, 1918).

During the European war the Dakin-Carrel method, applicable to the treatment of infected wounds was devised. (See under PROPHYLAXIS). Shortly after its introduction, Dakin produced a series of substances which, while highly bactericidal, are not irritating to the tissues, viz., the chloramines. Favorable results have been obtained with these substances in civil practice.

Dichloramine-T (tolueneparasulphondichloramine) was originally

used in a 5 or 10 per cent. solution in chlorinated eucalyptol or chlorinated liquid petrolatum. Eusol is a preparation of hypochlorous acid first made by Lorrain Smith, of Edinburgh.

Preparation of dichloramine-T by the *Chatlaway method* described as follows: Chlorinated lime (from 350 to 400 Gm.—11½ to 13½ ounces) of good quality is shaken with 2 liters (quarts) of water on a shaker for half an hour, and the mixture allowed to settle. The supernatant fluid is siphoned off and the remainder filtered. Powdered tolueneparasulphonamid, 75 Gm. (2½ ounces) (the crude product may be used), is then added to the whole of the hypochlorite solution and shaken until dissolved. The mixture is filtered, if necessary, placed in a large separating funnel and acidified by gradual addition of acetic acid (100 c.c.—3½ ounces). Chloroform (about 100 c.c.—3½ ounces) is then added to extract the dichloramine, and the whole well shaken. The chloroform layer is tapped off, dried over calcium chloride, filtered, and allowed to evaporate in the air. The residue is powdered and dried in vacuo. The product sold as **chlorazene** may be substituted for the tolueneparasulphonamid. Keen ("Treatment of War Wounds," 1917).

The Edinburgh preparation known as **eusol** is made up as follows: To a liter (quart) of water 12.5 Gm. (3½ drams) of bleaching powder (chloride of lime) are added and shaken vigorously. Then 12.5 Gm. (3½ drams) of boric acid powder are added, and it is again thoroughly shaken. Upon standing over night and filtering it is ready for use. The solution contains hypochlorous acid 0.54 per cent., calcium bichlorate 1.28 per cent., and calcium chloride 0.17 per cent. It should be kept well corked in dark-colored bottles, and is effective for 1 month.

The preparation is non-toxic, keeps the wounds bathed in lymph which

contains antibodies, is practically painless, dissolves necrotic tissue, causes wounds to lose their fetid odor, and is hemostatic. It has been given intravenously in some cases. C. H. Gilmour (Can. Jour. of Med. and Surg., Feb., 1917).

The author's oily solution of **dichloramine-T** is held by him to give as good results in infected military wounds as, and to have several advantages over, older methods. Thirty-five c.c. (1½ ounces) sufficed to dress 42 wounds. Its use eliminates the Carrel tubes and reduces the frequency of dressings to once in 24 to 48 hours. It greatly reduces the amount of cotton and gauze required, as well as the soiling of bed linen. J. E. Sweet (Jour. Amer. Med. Assoc., Sept. 29, 1917).

In extensive experimentation, a chlorinated paraffin wax oil proved the most satisfactory solvent for dichloramine-T. It is commonly called **chlorcosane**. It is readily prepared from cheap constituents, has a viscosity between those of olive oil and castor oil, is bland, dissolves dichloramine-T up to 10 per cent., and the solution retains its activity for two months if stored in amber bottles. The solution is suitable for use on wounds and can be nebulized by a power spray. Dakin and Dunham (Brit. Med. Jour., Jan. 12, 1918).

The chloramines present all the advantages of sodium hypochlorite, which they set free, besides being much less irritating to the skin and acting for a longer period. They are inferior only in their power to dissolve necrotic tissues. **Chloramine-T** is but slightly toxic, and as a bactericidal agent is 4 times as strong as sodium hypochlorite.

In infected wounds a 2 per cent. solution may be used by intermittent irrigation every two hours; clean wounds are thus rapidly sterilized, but wounds with dead tissues, much more slowly. As a collyrium a 2 to 4 per cent. solution may be used; in urethritis, copious irrigations with a 0.5 per cent. solution; in mouth in-

fections, washings and gargling with a 1 per cent. solution, and for the disinfection of germ carriers, spraying of the nose with a 0.5 per cent. solution. A 5 per cent. chloramine gauze, applied dry, is serviceable. A paste containing 8.5 per cent. of sodium stearate and 1.5 per cent. of chloramine-T exerts a detergent action in wounds covered with dead tissue and sterilizes the wound surface. Dichloramine-T is likewise a powerful antiseptic, but its oily solution is unstable. Halazone, a third chloramine product, was prepared by Dakin for the sterilization of drinking water. One or two tablets of it, added to a liter of water, sterilize it rapidly and leave no taste. Guillot and Daufresne (Paris méd., May 4, 1918).

The dichloramine-T oil method of wound treatment is simple of application and the results from it, even when judged by modern standards, are not to be disregarded. It is, however, not indifferent to granulation tissue nor to the skin edges of wounds, but has, especially if used for a long time, a deleterious action on both. The oily menstruum does not altogether prevent adhesion of dressings to the surface. On the whole, dichloramine-T oil has not yielded the improvement on Dakin's solution that was anticipated. Morrison, Hartley and Bashford (Lancet, Aug. 24, 1918).

Report on 19,040 cases in civil surgical practice treated with dichloramine-T. Its use has definitely improved the results in the primary closure of traumatic wounds of the soft tissues, bones, and joints. In superficial accessible affections it uniformly gave better results than any other germicide. The best results can only be obtained when actual chemical contact with the infecting organism is maintained. Unlike the aqueous hypochlorite (Dakin's) solution, dichloramine-T has no disintegrating effect on catgut. As a deodorant dressing it is of great value. Packing putrid, sloughing, malignant tissues lightly every 6

hours with gauze saturated with a 5 per cent. solution of it overcomes odors entirely and controls wound infection. (Milit. Surgeon, Sept., 1918).

Experiments showed that the chlorinated antiseptics have no power to penetrate blood clots and destroy bacteria therein contained. The fibrin is probably the resistant substance, as the plasma and blood cells are easily dissolved by these antiseptics. Taylor and Stebbins (Jour. of Exper. Med., Jan., 1919).

Another innovation introduced through war practice was the employment of antiseptic dyes, such as flavine and brilliant green, in wound treatment.

Acriflavine is more active than proflavine and is markedly selective in its action on streptococci and less so on staphylococci, while almost without effect on certain other organisms. It has a toxic action on tissues, but this is not such as to make its use inadvisable in solutions of about 1:4000 strength in infections with streptococci and staphylococci. Its application should follow thorough cleansing of the wound with a rapidly acting antiseptic such as Dakin's solution, followed by normal saline. W. P. Morgan (Lancet, Feb. 16, 1918).

Brilliant green in 1:500 solution in $\frac{1}{2}$ per cent. chloretone used in severe wounds received for treatment within two to eight hours after injury. The dye stains all damaged tissues more than the healthy and thus aids in determining just how much tissue should be excised. The drug produced exuberant, vascular granulations, was painless, rapidly removed edema and inflammation, and exerted a favorable antiseptic action. R. Massie (Lancet, May 4, 1918).

In using flavine in septic injuries, all affected parts should be reached. The writer always tries to introduce the solution by means of a hypodermic or dental syringe. The flavine-soaked gauze should always be applied as wet as possible and any cavi-

ties filled up with the solution. If applied continuously, a yellowish pellicle appears on the wound surface in a few days. A change should then be made to **eusol**, brilliant green, or **magnesium sulphate** about the fourth day, and subsequently a return to flavine made once every three days. This method gave great satisfaction. Savery (Brit. Med. Jour., Sept. 14, 1918).

Humphrey's formula of an emulsified preparation of **acriflavine** recommended as a wound dressing: **Acriflavine**, 0.1; **thymol**, 0.005; white wax, 4.0; liquid paraffin, 76.0, and distilled water, 20.0. The emulsion is sealed in small sterile bottles. The addition of **thymol** affords better results in cases with mixed infection. In broken down tuberculous glands, after scraping, a little of the emulsion is introduced before the wound is closed. Stowell (Brit. Med. Jour., Mar. 1, 1919).

Rutherford Morison's **bismuth iodoform** ("Bipp") paste is intended to gradually asepticize wound cavities and reduce the frequency of redressings. Fairly good reports from its use have appeared, but it seems to have been the cause of a number of cases of bismuth intoxication.

The writer treats infected war wounds as follows: Under an anesthetic, usually open ether, cover the wound with gauze wrung out of 1:20 phenol, and clean the skin and surrounding area with the same lotion. Open the wound freely, sparing nerve trunks and muscular branches of nerves. Cleanse the cavity with dry sterile mops, Volkmann's spoon, etc., and remove all foreign bodies. Mop the skin and cavity with methylated spirit. Rub **bismuth iodoform** ("Bipp") paste well into all parts of the wound with dry gauze, removing any gross excess: **Iodoform**, 16 ounces (480 Gm.); **bismuth subnitrate**, 8 ounces (240 Gm.); **liquid paraffin**, 8 fluidounces (240 c.c.), or a sufficient quantity to form a paste.

Rub down the paste, in small quantities at a time, on a slab with a spatula, to insure freedom from grit, etc. Dress with sterile gauze, and cover with an absorbent pad. This dressing requires no change for days or weeks if the patient is free from pain and constitutional disturbance. Should discharge come through, the stained part must be soaked in alcohol, and a gauze dressing wrung out of the same applied as a further covering. In redressing, the wound is covered with cotton soaked in alcohol, and the discharge wiped off the surrounding skin. The paste in the depths is clean and is not disturbed. Rutherford Morison (Brit. Jour. of Surg., Apr., 1917).

Two thousand cases of recent wounds seen in civil practice, with less than 1 per cent. of infections. The procedure followed was similar to that of Morison. Hemorrhage is controlled by pressure with dry gauze and twisting off small spurting vessels. The skin is then cleansed with $\frac{1}{2}$ per cent. iodine in benzine, the wound laid open, dirt removed, and ragged edges trimmed. **Bipp** paste is then applied freely and rubbed thoroughly into the tissues, the surplus wiped away, and the skin edges brought together and held until bleeding ceases. Buried catgut sutures are avoided and the edges coapted with adhesive strips if they gape widely. M. L. Emerson (Jour. Amer. Med. Assoc., Jan. 12, 1918).

Following formula for **Bipp** recommended: **Bismuth subnitrate** (C. P., arsenic-free), 10; **petrolatum** or white wax, 10; **iodoform**, 4; **olive oil**, 15, more or less, to suit the wound. The oil and petrolatum are heated to boiling, the bismuth stirred in, the mixture cooled to 70° C., and the **iodoform** added. Before using, heat again to 70° C. This paste never proved toxic. E. Calandra (Polislinico, Aug. 11, 1918).

Among other varieties of wound treatment which were applied with more or less success during the war

and are doubtless destined to be of some value in civil practice were **hypertonic salt solution, magnesium compounds, and heliotherapy.**

Recent infected wounds, with dead tissues excised, and opened out flat, can be sterilized by **sunlight** in 48 hours. The first period of insolation lasts $\frac{1}{2}$ hour, and the second $2\frac{1}{2}$ hours. After 6 days such a wound could be sutured. In deep wounds and fractures, sterility was obtained in 4 to 6 days. Where the sunlight is subdued the wounds can be safely exposed for a long time; where bright and hot, small progressive doses are indicated, not exceeding 15 minutes on the first few days. Leriche (*Presse méd.*, May 24, 1917).

A 1.5 per cent. dilution of Javel solution (*liquor sodæ chlorinatæ*), containing but 0.042 per cent. of sodium hypochlorite (12 times less than the Dakin or Daufresne solutions) was used by the writers in 510 cases of infected wound, including 155 compound fractures and 286 deep wounds of soft tissues. In the whole series there were but 3 deaths, including 1 from tetanus and 1 from grave icterus. The diluted Javel solution showed greater bactericidal power than Dakin's solution without its irritating property. Cazin and Krongold (*Presse méd.*, Nov. 1, 1917).

Following **paste** recommended for infected wounds: Dried **magnesium sulphate**, $1\frac{1}{2}$ pounds (700 Gm.); **glycerite of phenol** (10 per cent.) or **glycerin**, 11 ounces (330 Gm.). The latter is placed in a hot mortar and the finely powdered magnesium sulphate slowly stirred in. The paste is very hygroscopic and is kept in tight jars. It is packed into all crevices of the wound and a dressing of cotton and gauze applied. Profuse serous discharge occurs. When the dressing is removed after three to eight days the discharge is seropurulent and the wound covered with bright red, healthy granulations. A **saturated aqueous magnesium sulphate solution** is then used and the wound later

closed or grafted. A. E. Morrison (*Brit. Med. Jour.*, Mar. 23, 1918).

Infected wounds healed up very quickly under **hypertonic salt solution** in 120 cases. The indications for it are infected, infiltrated walls in the wound cavity. Permin (*Hospital-stid.*, Apr. 3, 1918).

At all seasons direct **sunlight** rays have a positive therapeutic value. Not to use them is a waste in the treatment of the wounded whose beds receive the sunlight. The wound should be exposed, the window opened, and a coarse wire screen used to keep off flies from the wound. The exposures are for fifteen minutes to two hours. The sunlight acts like a drain, the edematous tissues pouring out septic fluid, droplets of which become visible in ten to twenty minutes. Léo and Vaucher (*Paris méd.*, July 27, 1918).

Hepatic lipoids are prepared by hashing up liver tissue, drying it well at 70° C., reducing it to a powder, and placing it in a Soxhlet apparatus for ether extraction. With the lipoids thus obtained, a 5 to 10 per cent. emulsion in sterilized olive oil is aseptically prepared. A few mils of ether are added from time to time. Before use it is slightly warmed in hot water and well shaken. The emulsion is applied to wounds every other day, after cleansing with sterile saline solution. In sinuses and suppurating cavities it is introduced with a gauze wick or syringe. Small uninfected wounds heal in three to five days. Pain and burning are immediately allayed. In broad, suppurating wounds, the lipoids soon arrest suppuration and lead to complete healing in eight or ten days. E. Savini (*Paris méd.*, Aug. 17, 1918).

Good results in wound disinfection from passing over the wound an air current laden with **antiseptic vapors** such as **ether, phenol, camphor, and oil of geranium**. The air is passed through a flask containing the antiseptics and introduced into the deepest part of the wound through a rubber catheter. The gaseous injec-

tion is kept up both day and night. Infected wounds are completely transformed in 24 to 48 hours, even where ordinary treatments have failed. The cost is very slight, and the annoyance of having the bedclothes wet from continuous liquid irrigation is avoided. Lavenant (*Presse méd.*, Dec. 19, 1918).

Specific treatment of infected wounds by means of **serums** and **vaccines** has been attempted. The French serum of Leclainche and Vallée, used locally, seems to have given especially gratifying results in this connection.

Specific **serum prophylaxis** in infected wounds recommended. Polyvalent serums are used in the form of dressings or hypodermic injections. In the hands of Bazy, Quénu, and others this treatment has given excellent results. According to Quénu it checks suppuration and promotes epidermization. In the case of the *B. pyocyaneus*, however, a weak **silver nitrate** solution is best. Leclainche and Vallée (*Presse méd.*, Apr. 2, 1917).

Normal **beef serum** used in the treatment of wounds. Gauze soaked with it should touch every part of the wound and be packed into blind pockets with dressing forceps. The dressing should be kept moist. In diffuse cellulitis, irrigation is practised by means of a syringe into the rubber tissue or tubings used in the dressing. In burns, dressings are moistened *in situ*, and changed only once a day. Fresh wounds are cleansed, irrigated with serum and sutured, where it is possible to approximate the skin edges, and a serum dressing applied externally, not to be disturbed for three or four days, unless evidences of sepsis appear. Serum controls septic processes. It is harmless to normal tissue, valuable as a prophylactic in fresh wounds, a marked stimulant of granulations, and causes no anaphylactic reaction. Shortell, Corting, and

T. Leary (*Boston Med. and Surg. Jour.*, Nov. 1, 1917).

A **sensitized autovaccine** proved very useful in war wounds. A loopful from the depths of the wound is incubated on agar for 48 hours, and all the colonies formed then scraped off and suspended in 5 c.c. (80 minims) of polyvalent serum. The resulting vaccine has the rapid immunizing properties of a prepared serum and also the durable immunization of a vaccine. The emulsion is incubated for 1½ hours, centrifuged, the sediment rinsed twice with saline solution, heated twice for an hour to 50° or 60° C., and the preparation adjusted to 50 million per c.c. One c.c. (16 minims) is injected in the scapular region. Interminable suppurations are arrested by this treatment. Julien and Tholozan (*Presse méd.*, Feb. 6, 1919).

Babcock's Method.—This is a procedure devised for the immediate sterilization and closure of chronic infected wounds of bones and soft tissues. Its technique is given below (*N. Y. Med. Jour.*, June 21, 1919):—

1. **Skin Preparation.**—If possible the wound area should be prepared by daily shaving, washing with **soap and water**, removal of all scabs and crusts, and the application of 2 per cent. **yellow oxide of mercury ointment** for three days preceding the operation.

2. **Wound Sterilization.**—On the operating table, the skin is (a) Thoroughly scrubbed with "B" solution (**Liquor cresolis comp. 2, turpentine 10, and gasoline 88**). (b) Painted with 3 per cent. solution **tincture of iodine**. (c) Sterilized by a saturated **zinc chloride solution**, thoroughly injected under pressure into all sinuses and cavities, applied to all unhealed and granulating surfaces, and rubbed over the scar and adjacent skin. Five minutes are allowed for penetration of the zinc solution, and great care is taken that every recess of the wound is reached.

3. **Color Delineation.**—The following antiseptic staining solution is then thoroughly applied to all eroded surfaces and injected under pressure into all cavities and sinuses:

<i>Saturated alcoholic solution of</i>	
<i>methylene blue</i>	20
<i>Caustic potash</i>	3
<i>Phenol</i>	3
<i>Ether, to make</i>	100

As soon as this has evaporated, the exposed granulating surfaces are left dark blue black, dry, bloodless on manipulation, and sterile. The coloring penetrates to 3 millimeters. Outside of this is a much wider zone of a vascular, grayish white tissue, sterilized by the zinc chloride.

4. *Excision of Infected Area.*—The entire field is again painted with tincture of iodine and a very free skin incision made, planned for later closure, and well outside of all scars and sinuses, which are to be excised as nearly as possible *en bloc*. The instruments are now changed, the skin margins separated from underlying tissues by sharp retractors, and dry towels or gauze clipped in position to protect all skin margins. The incision is now deepened to the bone; the periosteum is freely incised, retracted, protected by towels or gauze, and, beginning some distance from the disease, with sharp chisels the infected bone is freely excised with the attached overlying skin, scars, and sinuses. Care is taken not to divide completely the bone.

A blue color indicates that all infected areas have not been excised, and the incision is to be continued. The operator should work outside the septic focus and use very sharp knives, gouge, and chisels, rather than curettes. If possible, all soft tissues and bone should be removed to at least 1 centimeter external to the blue coloration. The bone incisions should leave smooth, vascularized surfaces with no holes to form "dead spaces."

5. *Wound Closure.*—The muscles and soft tissues are sufficiently freed from the skin, bone, and each other, to fit into the bone defects. Bleeding is carefully controlled with the smallest amount of plain catgut. If necessary, a few fine catgut sutures unite the deeper tissue layers, and the skin is closed with silk-worm gut. In very large wounds, 1 or 2 small tube drains may be left between stitches to drain the depths of the wound for the first 24 or 48 hours. Only a dry technique is employed. Excess of zinc chloride may, if necessary,

be neutralized by a 10 per cent. solution of sodium bicarbonate. This is rarely necessary. Voluminous, very wet boric alcohol dressings are applied until all tissue reaction has subsided and healing occurred.

General Measures.—When, notwithstanding judicious local measures, general infection, *septicemic* or *pyemic*, occurs, efforts should be made to enhance the autoprotective functions of the body at large.

Some surgeons speak well of anti-streptococcic serum, injecting 10 c.c. (2½ drams) or more into the wall of the abdomen, and repeated several times a day. It can do no harm, but its actual value is doubted by many. **Vaccines** have also been tried, but even Sir A. E. Wright states that "in cases in which septicemia has supervened the results are scarcely encouraging."

Septicemics should be given plenty of fresh air and should be fed as liberally as possible without deranging the digestion. The hot pack is indicated in septicemia marked by high temperature and erythema and in the absence of more serious complications, with stimulation before and after the pack. Quinine should be given in small doses and often. Apparently good results have been obtained by hypodermoclysis. The continued use of autogenous vaccines is justified. Spinal puncture is indicated for meningismus. Abderhalden (Amer. Assoc. Immunologists; Jour. Amer. Med. Assoc., July 15, 1916).

Case of a man wounded in the shoulder, in whom septicopyemia developed. Blood cultures revealed streptococci, and the patient soon became cachectic. Peptone injections, as advised by Depage and Nolf, were then given. After the twelfth injection of 10 c.c. (2½ drams) on alternate days, fever completely subsided. A 10 per cent. solution of pure, bacteriological peptone is made in sterile water and heated to 120° C. The re-

sulting flocculent precipitate is filtered off on a hot filter and the residual solution put up in 10 c.c. ampules which are sterilized again in the autoclave. Subcutaneous injections are safe. For the first injection the solution should be diluted. Intravenous injections, if used, should be given very slowly. Potel (*Presse méd.*, July 12, 1917).

Favorable report from intravenous injection of isotonic sugar solution in septicemia. The leucocytes jumped from 5000 or 7000 up to 25,000 in less than half an hour, remained thus for two or three hours, and even then did not decline below 16,000. The reaction resembled that occurring after colloid metals—slight fever, chill, and sweating. The solution also provides nourishment and brings on diuresis. The isotonic solution is of 4.76 per cent. strength with glucose; 10.35 per cent. with saccharose, and 10.89 per cent. with lactose. From 300 to 500 Gm. (10 to 17 ounces) are injected at a dose, up to 1000 or 2000 Gm. (1 or 2 quarts) a day in grave cases. Enough is injected to keep the leucocytes at about 25,000. The procedure is also applicable in erysipelas and rheumatism. Audian and Masmonteil (*Presse méd.*, Nov. 8, 1917).

Attention called to the striking discrepancy between the slow agglutination of bacteria *in vitro* and their usual immediate disappearance when injected into the blood stream. Experiments showed that the bacteria quickly become adherent to the blood platelets, which themselves likewise become agglomerated and diminish in number. Natural immunity to a germ arises merely from this property of the platelets. *In vitro*, platelets show selective power, promptly separating staphylococci injected into the circulation from pneumococci, which remain free and separate. The various non-specific agents at times used successfully in septicemias, such as colloid metals, peptone, non-specific serum, and dead bacteria, all induce, when injected intravenously, agglutination of the blood platelets and a

leucopenia. P. Govaerts (*Presse méd.*, Nov. 25, 1918).

Twenty-nine cases of proved septicemia treated with arspenamine, with 17 recoveries. The treatment was beneficial when used early in septicemias associated with primary foci easily accessible to surgical interference. In endocarditis and other conditions in which secondary localizations had become firmly established, its use was disappointing. S. R. Haythorn (*Med. Soc. State of Penna.*; *Med. Rec.*, Nov. 23, 1918).

PUERPERAL SEPSIS.

Any of the following septic conditions may develop in the puerperium: Septic vulvitis, vaginitis, metritis and endometritis (including sapremia), salpingitis, oöphoritis, or peritonitis (local or general); pelvic cellulitis (including pelvic abscess); septic thrombosis, and septic pyemia. By far the most frequent and important of these, however, are metritis, peritonitis, and pelvic cellulitis.

SYMPTOMS.—The earliest symptoms of septic infection appear, as a rule, about thirty-six hours after the termination of labor. The initial chill is frequently mild and overlooked, but the pulse and temperature afford more distinct indications. When the former increases in rate and the latter rises above 99° to 100° F. at this period, septic disease may be suspected, and the suspicion is strengthened if a laxative fails to eliminate the disturbance. If the pulse rises to 120 or 140 in the presence of the temperatures just mentioned, the condition is likely to be a severe and dangerous one, being frequently attended with general purulent peritonitis. A temperature of 103° to 104° with a pulse rate of 115 to 120, even if persisting for days, indicate rather a septic infection confined to the pelvic organs.

Along with the changes in pulse rate and temperature the lochial discharge may diminish or completely cease; it may also acquire a foul odor. If the arrest of lochia is due merely to stenosis at the internal os, the examining finger may find the body of the uterus flexed on the cervix and the constitutional symptoms lessen upon straightening out of the flexion. Lochial fetor indicates sapremia, and is not a necessary accompaniment of infected uterus. It usually results from a decomposing portion of placenta, membrane, or blood clot in the uterus, but may instead arise from a sloughing pelvic floor or cervix. The uterus is relatively large.

Pain is generally not present in early sepsis, though tenderness on pressure over a septic uterus will be noted. Pain becomes pronounced as the peritoneum becomes involved. Sharp and radiating pain results from an exudate in the pelvis, and phlebitis likewise induces sharp pain.

Where endometritis exists in the absence of sapremia, the initial chill is followed by a rise in both the pulse rate and the temperature, and the lochial discharge, at first reduced or suppressed, is likely to become free or even profuse later on, as the endometrium undergoes necrosis and sloughs off. Tympanites appears early, pain late, and where treatment is inadequate, multiple thrombosis and embolism may follow. Apparent convalescence may be interrupted by extension to the tubes or peritoneum.

Pelvic cellulitis is often an associate of peritonitis, but may occur independently and run its course without involvement of the tubes and ovaries. In puerperal cellulitis following laceration of the cervix, there

may be a slight chill about the third or fourth day after labor, and upon local investigation, a boggy condition of one or both of the lateral vaginal cul-de-sacs is noted. The temperature and pulse rate rise and remain elevated from a few days to a week. If suppuration then sets in, the cul-de-sac softens and the temperature may drop, while the pulse remains high. If peritoneal infection coexists, there may be tympanites and the pain may radiate over the abdomen.

Severe tubal and ovarian infection from the uterine cavity may pass into peritonitis within a few days. If of a lower grade, the acute symptoms may soon abate and a chronic salpingitis and oöphoritis ensue.

ETIOLOGY.—Puerperal sepsis has been held to be always exogenous *i.e.*, due to the introduction of infection from without. Many now believe, however that it may be due to autoinfection from the vaginal secretions. The germ most frequently causative is the streptococcus, and next to it come the gonococcus and staphylococcus. Many other less frequently present organisms, including the colon, diphtheria, typhoid and Welch's gas bacilli, have been found.

DIAGNOSIS.—Apart from the clinical diagnosis based on the symptoms already referred to, bacteriological examinations of the vaginal or uterine discharges, as well as of the blood, are of considerable value. Potocki (1918), in 196 cases of puerperal infection, found blood cultures positive in 91, or 46.4 per cent., in 93 per cent. of the positive cases a single organism, the streptococcus, was found. Increasing numbers of an organism in the blood may warn of an impending fatal termination.

TREATMENT.—The treatment depends upon the nature of the infection present. Where there is digital or other evidence of the retention of secundines or clots, the blunt curette or, if possible, the finger may be used to remove the offending material. In the absence of such retention, rest, promotion of elimination, and the use of vaccines or serums to enhance immunity are the chief initial indications. Cold may be applied to the abdomen in the acute stages and later hot applications to favor absorption of exudate. Intra-uterine douches of antiseptic agents are, as a rule, no longer considered valuable. Where infected lochia are being retained, however, aseptic irrigation of the uterine cavity is advised. Fresh air day and night, feeding to the limit of gastric tolerance, and the use of stimulant and supporting drugs such

as ammonium carbonate and digitalis are recommendable. Water should be given freely by mouth and bowel. Autogenous vaccine seems to have been particularly useful in colon bacillus infections. In extraperitoneal pelvic abscess, with fluctuation, the indication is to incise through the vagina and treat the condition aseptically. For an exudate under or within the broad ligament, frequent hot douches may be tried at the start. In thrombophlebitis, ligation of the pelvic veins has sometimes yielded good results. Peritonitis is treated by the usual means. (For additional constitutional measures, see ante, TREATMENT under SEPTICEMIA.)

ERNEST LAPLACE,
Philadelphia.

WOUNDS, VENOMOUS. See INDEX.

X

XANTHOMA.—Xanthoma, xanthelasma, or vitiligoidea, is a connective-tissue growth, in the form of circumscribed, flat or slightly raised yellowish patches or tubercles, commonly located on the eyelids. Two varieties are noted, the macular (xanthoma planum) and the tubercular (xanthoma tuberosum).

Xanthoma planum is usually found on the eyelids, in pea-sized or larger, soft, smooth, flat or slightly elevated, circumscribed patches the color of chamois-leather. The favorite seat is near the inner canthus. Its development is slow.

Xanthoma tuberosum is usually found upon the neck, body, or extremities, occurring in patches or tubercles, pin-head to pea sized or larger, rounded and yellowish. They are slightly elevated and may be large. Closely set aggregations of smaller nodules unite to form the larger patches. The favorite seat of the disease

is upon areas subject to pressure as the elbows, knees, knuckles, palms, soles, and buttocks, although occasionally found upon the face, neck, chest, and other localities, and more rarely the mucous membrane of the mouth, pharynx, esophagus, and respiratory tract. Nodules in the liver occasion jaundice.

The two forms may be present at once, and when the lesions are numerous the disease is known as xanthoma multiplex.

ETIOLOGY.—Xanthoma usually occurs in middle life, rarely in childhood. Women are more often affected. Occasionally there is a hereditary history. In other cases hepatic disease, rheumatism, and other metabolic diseases are factors.

PATHOLOGY.—S. Pollitzer differentiates, pathologically, xanthoma of the eyelids which is a product of a peculiar degeneration of the muscle-fibers, the only resemblance to the rarer widespread form

being the presence of a large amount of fatty substance.

PROGNOSIS.—The lesions tend to be stationary after reaching a certain size.

TREATMENT.—The disease yields sometimes to applications of **monochloroacetic acid**; when ineffectual the patches may be removed by means of the **knife**, **galvanocautery**, or **electrolysis**; recurrence is rare. **Radium** and the **high-frequency spark** have been used with success.

XANTHOMA DIABETICORUM.

This disease occurs in diabetic patients and is unrelated to other varieties. It occurs as numerous pin-head to pea-sized obtusely conical, orange-red papules or tubercles, located upon the extensor surfaces of the extremities, upon the neck, loins, buttocks, etc., with itching and burning. The center of the lesion is generally yellow, with a small reddish areola. The development of the eruption is comparatively acute. It may disappear suddenly and reappear later. Obese, florid, middle-aged men are most subject to it.

PATHOLOGY.—These lesions, according to Johnson, are produced by an exudative inflammation with proliferation of fixed tissue elements (fibroblasts and endothelial or epithelioid cells), in the latter of which fatty change occurs (xanthoma cells), whilst free fat infiltrates the tissues. Sherwell believes that this disease is not a true xanthoma, but an inflammatory condition resembling it.

PROGNOSIS.—This is generally favorable. The lesions tend to recur, but this depends on the glycosuria.

TREATMENT.—The treatment is that of the underlying **glycosuria**. Proper dietetic and medicinal treatment will cause disappearance of the eruption. W.

X-RAYS AND RADIUM.—The therapeutic uses of radioactive agents having been reviewed in the articles on the various diseases in which they are indicated, and also in the Index-Supplement, this section will be devoted mainly to their mode of action and the general principles governing their therapeutic use.

X-RAYS.—Physiological Action.

The application of the Röntgen rays in therapeutics is based upon the fact that living tissues which have been subjected to the rays undergo certain definite metabolic changes. These changes pass successively through the stages of stimulation, irritation, degeneration, and destruction, depending upon the amount of rays absorbed by the tissues, and upon the selective action of the rays for certain tissues.

In addition to the local effects of the rays, there seems to be, in some instances, a constitutional effect as well. As an instance of this we often see, in the treatment of certain skin diseases, improvement of lesions situated at a part of the body remote from the area which is being treated. This is probably due to formation of antibodies or vaccines.

The X-rays have a selective action on pathological tissues, and this is the keynote of Röntgen therapy. The object is to throw a dose of rays into the tissues which will cause the greatest destruction possible to pathological tissue, with a minimum of reaction in the normal tissues. The more closely the cells of pathological tissue approach the embryonal type, the more susceptible are they to the rays.

At the time a treatment is given, no sensation, whatever, is caused by the rays. A slight sensation of warmth, noticed by some patients, is due to high frequency discharge from the tube. A single mild dose causes no visible changes in the skin. A somewhat heavier dose will, in the course of a few days, set up a slight erythema, probably accompanied by itching. This irritation is usually

very transient. If a succession of similar doses be applied at intervals of a few days, the skin reaction will go on to a stage of bronzing and desquamation. This condition, likewise, will usually disappear if treatment is discontinued soon enough.

Untoward Effects.—After a dangerously heavy dose of the rays, in the course of a few days, a more intense erythema is noted, followed by the formation of vesicles, later by bullæ and, finally, by necrosis and ulcer formation, with deep destruction of the tissues. These ulcers, or X-ray burns, are very painful, and show very little tendency to heal. This is explained by the fact that the intima of the blood-vessels is thickened and swollen, there is proliferation of the endothelium, and the lumen may be completely blocked. It is a case of starvation of the part by loss of blood-supply.

An important feature of the X-rays is that their effects are cumulative, and much the same result as the above may follow a succession of small doses, none of which is in itself harmful. If such a cumulative action did not exist, and the effect of each dose passed off rapidly, mild exposures continued over a considerable time would accomplish nothing.

Therapeutic Dosage.—Inasmuch as many pathological conditions are aggravated rather than benefited by too small a dose of X-rays, it is our object to give as heavy doses as possible without crossing the danger line and producing a severe reaction. As the skin is the most sensitive normal tissue to the effect of the rays, the maximum dose that can be thrown into the tissues and produce simply a mild and transient erythema is

spoken of as an "erythema dose." This represents the limit of safety to which a single treatment may be pushed, and this skin area must be carefully avoided in subsequent treatments for a period of three or four weeks, until all reaction has subsided.

Apparatus.—Prior to the last three years there was little uniformity in the apparatus used by different röntgenologists. Some used the induction coil for the production of their electrical energy, others the high-frequency coil, and some few clung to the static machine. The tubes used with these different forms of apparatus were of many types and exceedingly unstable as to vacuum and penetration. At the present time, however, röntgenologists in this country, at least, are practically all doing their treatment work with one of the standard types of interrupterless transformer and the Coolidge tube.

The Coolidge tube, named for its inventor, Dr. William D. Coolidge, of Boston, a physicist, has revolutionized the technique of radiotherapeutics. This tube is devised to be entirely free of gas, and has a vacuum 1000 times greater than the ordinary tube, so that it is impossible to pass a current through it in the ordinary way, even with the most powerful apparatus. Both anode and cathode are made of tungsten. The cathode consists of a spiral tungsten filament, which, when electrically heated by a storage-battery circuit, gives off the stream of negative electrons required for the generation of the X-rays. A molybdenum sleeve around the spiral filament is used to focus the cathode stream upon the target. The number of electrons

given off from the cathode is regulated by changing the temperature of the tungsten spiral. This is done by means of a rheostat in the storage-battery circuit.

The *technique* of operating one of the Coolidge tubes is as follows: The primary current from the storage battery is turned on and the tungsten filament in the cathode is allowed to heat up. While in this condition the high-tension current from the interrupterless transformer is delivered to the tube terminals in the usual way. By regulating the degree of heat in the tungsten spiral, by means of a rheostat in the battery circuit, any degree of hardness and any quality of rays may be obtained. One may be working one minute with the tube so soft that the blood-vessels in a baby's arm will show in a *radiogram*, and by a quick adjustment of the rheostat, rays so hard and penetrating are obtained that a radiogram of a skull may be made to appear as though entirely devoid of soft parts. The remarkable advantage of this tube to the röntgenologist lies in the immense output for deep therapeutic work. It is quite practicable, with this tube and a good transformer, to give a full erythema dose of rays in one minute. With this tremendous reduction in the time required to give a full treatment, however, the danger of producing X-ray burns is much greater, unless extreme caution be used in estimating proper dosage.

Estimation of Dosage.—Many methods have been introduced for accurately determining the dose of X-rays absorbed in a given case. The parallel spark gap and the milliamperemeter reading are invaluable

guides as to the hardness of the tube, but they do not estimate the dosage of rays absorbed by the tissues. Ingenious methods to gauge this dosage have been introduced by Holzknecht, Sabouraud, Kienbock, Bordier, Hampson, and others.

The method most used in this country is that introduced by Sabouraud and Noiré, and modified by Hampson. The principle depends upon the action of the X-rays upon a disk of paper coated with platinum-barium-cyanide. These disks are of an apple-green color when fresh, and under the action of the rays they change to a yellow, orange, and finally a brown color. The Hampson radiometer, designed for the purpose of reading these various color changes, consists of a wheel, around the periphery of which is arranged a row of disks, 25 in number, of different tints. The initial or zero tint is the color of an unexposed Sabouraud pastille. Each higher number represents one of the tints assumed by a pastille under the continued action of X-rays. This wheel revolves back of an outer case, in which is cut a small aperture through which the tints can be successively viewed, one at a time, and compared with a pastille which has been laid on the skin of a patient in the direct path of the X-rays during a treatment. This comparison must be made by artificial light, either a gas-jet or an incandescent carbon light. A full erythema dose is obtained when a pastille has turned four divisions of the Hampson scale. In using this technique the tube is brought to a distance of about six inches from the patient's skin. Projecting from the diaphragm of the tube-holder is a cylinder of lead glass

about two inches in diameter and three inches long. This serves to confine the rays to a skin area two inches in diameter. By moving the tube-stand after an erythema dose has been given, a fresh skin area is brought under the outlet of the cylinder and a second erythema dose administered. A series of treatments may be given in this way, being careful that the circular areas treated do not overlap. In deep uterine therapy, for instance, 10 or 12 times the erythema dose may be directed to the uterus by moving the tube-stand to cover as many two-inch circles, and changing the angle of the apparatus each time, so that the rays are cross-fired from each area treated to their common destination.

Filters.—If the soft, non-penetrating rays are filtered out, a much larger dose may be administered with less danger to the skin, and much experimentation has been carried out to determine the best substances for this purpose. A combination which has been found very efficient in this respect is a plate of aluminum, 3 mm. in thickness, placed in the tube stand immediately beneath the tube, and a pad of sole leather, about 10 mm. in thickness, placed immediately on the skin surface.

Therapeutic Uses.—In this connection and as stated by Pirie (Int. Abst. of Surg., Aug., 1915) all cells can be stimulated, reduced in function or in growth, or destroyed, and we must decide which action of the rays is the one we desire to use. Under these three headings can be classified the diseases influenced by X-rays as follows:—

Diseases which benefit by X-ray stimulation: **Arthritis deformans (early),**

eczema, leukemia, lung tuberculosis, lupus, neuralgia, pruritus, psoriasis, sciatica, and tuberculous glands.

Diseases which benefit by reduction of tissue activity: **Acromegaly, carcinoma, exophthalmic goiter, high blood-pressure, hyperidrosis, hypertrophied prostate, hypertrophied thymus, menorrhagia, myoma uteri, ringworm, and rodent ulcer.**

Diseases which benefit by destruction of cells: **Carcinoma, hyperidrosis, hypertrichosis, myoma uteri, nevus, rodent ulcer, sarcoma, and warts.** The reader is referred to each individual disease in the general volumes and in the Index-Supplement for additional details and indications.

RADIUM.—The property of radioactivity was discovered by Professor Henry Becquerel, of Paris, in 1896, while conducting a series of investigations on the phosphorescence of uranium salts. Two years later Madame Curie, also of Paris, isolated from pitchblend, a substance which she called radium. Radium possesses to a higher degree than any other known substance the properties known as radioactivity. These properties are four in number, namely:—

1. Liberation of heat.
2. Liberation of light.
3. The power of ionization.
4. The production of certain rays which pass through opaque bodies, make impressions on photographic plates and produce various biological effects.

Physiological Action.—The biological effects of radium are similar to those of the X-rays, and the same underlying principle governing the therapeutic use of X-rays applies in radium therapy, namely, that patho-

logical tissues having an inferior resisting power, are attacked more vigorously by the rays than are the cells of normal tissue. In cases where the value of X-rays and radium are equal, the enormous cost of the latter makes it the less desirable therapeutic agent.

Therapeutic Uses.—The chief points which influence the choice of radium are: (1) The convenience with which it may be applied to several of the internal organs. (2) The ease with which it may be applied to the interior of a tumor mass. (3) The fact that it can be used with patients who are not in a condition to be moved to a special X-ray department.

The bulk of radium is so small that it is possible, by the aid of various forms of applicators, to introduce it under the eyelid, in the auditory canal, in the nose, mouth, throat, esophagus, stomach, rectum, vagina, and uterus. There are times when pathological conditions in these locations can be treated by radium when it would be difficult for the X-ray to produce the same therapeutic result without great destruction of tissue. In malignant tumors the same principle obtains, and sterile tubes of radium can be introduced into the tumor mass through incisions.

As regards the results obtained they are fairly represented by A. E. Pinch's report based on 860 cases treated in one year of various disorders at the Radium Institute of London. **Epithelioma** if flat, superficial, and accompanied by little or no ulceration yields satisfactory results. The results are also quite good in the

ulcerating forms, but require much longer treatment and leave considerable scar formation. Treatment of **epithelioma** of the mucous surfaces, on the other hand, is usually disappointing, though some temporary relief may follow. According to some, in skin cancer galvanic cauterization should precede the use of radium. In **inoperable carcinoma of the uterus** radium will often bring about results which cannot be obtained by any other mode of treatment, checking the rate of growth, or arresting it, and in some cases even converting the case into an operable one. In **cancer of the rectum** radium relieves the symptoms and usually retards the rate of progress. In **carcinoma of the breast** also there are encouraging results, especially in the sclerotic forms of growth. Of all forms of malignant disease **rodent ulcer** is by far the most amenable to the action of radium. **Superficial naevi** are usually quite successfully treated by radium, as is also the case with the cavernous forms. **Keloid** responds with most admirable results. **Parotid tumors** are also particularly amenable to treatment, even when malignant. **Lichenification of the skin** and some forms of pruritus are quickly cured, while **psoriasis** is also cured, but shows a tendency to later return. **Lupus vulgaris** does not respond to radium as well as it does to Finsen light. Lastly, the drinking of solutions of radium emanation is frequently very beneficial in **arthritis deformans**.

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Y

YAWS.—Yaws is a tropical specific infectious and contagious disease caused by a *Treponema* (*T. pertenue*), and characterized by papules, tubercles, and tumors having the appearance of raspberries.

SYNONYMS.—Yaws (Br.), pian (Fr.), bubas (Venezuela and S. A.), frambœsia tropica (Ger., Ital.), etc.

SYMPTOMATOLOGY.—Three stages are recognized.

The Primary or Prodromal Stage.—After a period of incubation, varying between 2 and 4 weeks, marked by malaise, rheumatoid pains, headache, and moderate, irregular fever, the primary lesion appears at the seat of the inoculation, which is always extragenital. The primary lesion is a papule, becoming moist after 1 week, and developing a yellowish secretion which forms a dry crust. The papules may be multiple and coalesce. The crust removed, an ulcer, with clean-cut edges and a granulating fundus, is left. This ulcer may heal, leaving a whitish scar, which may become pigmented; or it may become a granulomatous mass, resembling the granulomata of the secondary stage, but frequently larger. This large, single nodule is called "mother yaw," "maman pian," or "buba madre," and may be surrounded by several smaller granulomata. The primary sore is never indurated; it may be painful at first, but later is quite painless. The neighboring lymphatic glands may become enlarged and indurated, but they do not suppurate. The primary lesion may heal before the general eruption begins, but not as a rule.

The Secondary or Granulomatous Stage.—The general eruption usually begins 1 to 3 months after the appearance of the primary lesion, being preceded by malaise, headache, and severe pains in the joints, muscles, and bones. There may be fever of intermittent type. Minute, rounded papules, pin-head in size, appear on various parts, persist for many weeks and then disappear, leaving occasionally some furfuraceous patches; others become enlarged, coalesce, and acquire a dark areola in natives, a reddish one in Caucasians.

The tertiary stage is marked by gum-

matous-like nodules and deep, ulcerative processes, which may develop in any tissue. Osseous nodes and muscle contracture are common.

INFECTION.—Yaws is usually conveyed by direct contact. Insects, especially flies, may carry the disease. The disease is apparently not hereditary.

TREATMENT.—Potassium iodide, atoxyl, sodium cacodylate, quinine cacodylate, and mercury have been used with some success, but **salvarsan** and **neosalvarsan** are best; cure often follows a single dose. These remedies may be given by intramuscular, subcutaneous or intravenous injection, or by the mouth in alkaline solution. Castellani recommends the intramuscular and intravenous injections,

The intramuscular injections are given in the buttocks, after painting with iodine. The adult dose of salvarsan is 0.30 to 0.50 Gm. (5 to 7½ grains); in children, 0.03 to 0.04 Gm. (½ to ¾ grain) for each year of age, or 0.008 Gm. (⅓ grain) for each kilogram (2.2 lbs. av.) of weight. The injection, in the same dose, may be repeated after 2 or 3 weeks. For the manner of preparation of the solution to be injected, see Dioxidydiaminoarsenobenzol, vol. ii.) A suspension of the drug in olive oil (sterile) may be given subcutaneously in the interscapular region. The intravenous injections are made as in syphilis, in dose somewhat smaller than those mentioned above.

PROPHYLAXIS.—Abrasions of the skin should be properly treated with **antiseptics**. Patients with yaws should be isolated until cured, their skin lesions being properly dressed, so as to prevent them from spreading infection. The dwellings should be thoroughly disinfected.

YELLOW FEVER.—Time having fortunately sustained the view of Finlay, that the mosquito was the intermediary of infection of this disease, a fact ultimately demonstrated by the labors of Reed, Carroll, Agramonte, and Lazear, it is fittingly relegated to an inferior position, from the standpoint of relative importance, in the nosology of disease.

Having taken a small part in its undoing, I find it the source of greatest satisfaction to witness the final passing away of this terrible scourge. A. Agramonte (Sanidad y Beneficencia, January, 1916).

SYMPTOMATOLOGY.—As given in preceding editions by Surgeon Murray, of the United States Public Health Service, the symptomatology of yellow fever is as follows:—

The patient may complain of headache and malaise, with some gastric distress. A chill, or chilliness, is usually complained of. Distress in the early morning is a rule. Fever of 101° to 103° F. (38.3° to 39.4° C.), with pulse of 110 to 120; cutting pain through the forehead, with aching eyes; fullness of the latter with some pain and suffusion, generally with injection, may be observed. The back and thighs are painful in a severe case; there is some soreness in the mildest cases. Severe cases will also have pain in the back of the neck and in the calves. By pressing firmly and deeply over the region of the gall-bladder, one will generally elicit a sound resembling a squeak.

The face is full and less mobile than in health, with a fullness of the upper lip. The cheeks are more or less dusky, the hue depending also on the patient's color; they are sometimes faintly purplish. Sweating diminishes these facial signs in a few hours. There is congestion of the sclerotics, which increases, until after 36 hours, when they tend to become yellowish; in children, the eyes remain pearly. Frequently pressure on the eyeballs will cause pain, especially in bad cases.

Primary complete constipation or semi-constipation is always present. The superficial circulation is abnormal and sluggish; the skin may be streaked by passing the finger over it or paled for a quarter of a minute by pinching; this is a good sign, especially after the disease has progressed 36 hours. The skin is moist, as a rule, and stays so to the end, whether drugs are given or not. Yellowness of the skin is not to be looked for early. Unless there is nausea or headache, the patient lies quietly.

There is less rapidity of the pulse than the febrile condition present warrants,

judging from lung disorders and enteric fever. An inveterate smoker's pulse may become reduced when the amount of tobacco used is diminished. After 2½ or 3 days the pulse falls below 70 and later on lower yet, being out of all proportion with the temperature (Faget's sign); fright and irritation cause the slowness to pass unobserved. The pulse should be counted without the patient's knowledge.

The above signs are sufficient to warrant isolation, even if there is no known case of the fever within many miles.

After 60 hours there should be some albumin in the urine, but it may be absent. Anuria may exist, but in women this is not a reliable sign, while in children the urine is sometimes difficult to obtain. Albumin should not be confounded with mucin. Other symptoms should not be treated lightly because no albumin is found in the urine. At this stage some brown mucus, or black discharges, or "bismuth" stools may be looked for: early in mild cases—late sometimes in severe ones. Mild cases suffer from distaste for usual food only, there being anorexia from the beginning. The vomiting of the last food taken is usual, and bile is voided early if the early nausea is not checked, but no bile will be vomited during the 36 hours following proper bowel movements.

After vomiting the last food taken and a little bile, the vomit usually becomes white, and remains so until blood oozes into the duodenum or stomach: the source of the black vomiting. Hiccough and retching appear, and the black fluid may be heard regurgitating through the pylorus into the stomach.

Fulminant Cases.—Sometimes the symptoms appear in such rapid succession as to suggest that the attack will be necessarily fatal. Walking cases are also common. Murray refers to the case of a man who suffered from headache 3 days while on duty, black vomit occurring while he was on the stairs on the way to his death-bed.

DIAGNOSIS.—The diagnosis of yellow fever is usually easy; no febrile disease has as many pathognomonic signs. The early albuminuria, epigastric tenderness; the disparity between the rise of temperature and the pulse, the latter remaining low, and even declining (Faget's sign)

when the jaundice occurs and the black vomit are all typical. Castellani and Chambers state that the most important diseases from which it is to be differentiated early are *dengue*, which may be recognized by the absence of albuminuria, the preliminary rash and leucopenia; *subtertian malaria*, identifiable by the parasites in the blood and, in some cases, the typical 4-hourly temperature chart; *blackwater fever*, characterized by hemoglobin in the urine and the increase in mononuclears; *relapsing fever*, recognized by the parasites in the blood and the leucocytoses.

ETIOLOGY.—The natural habitat of yellow fever may be said to be the western coast of Africa, the West Indies, Central and South America down to the 40° of latitude. It does not prevail in Japan, China, or India, or anywhere in Europe, nor does it naturally occur anywhere on the mainland of the Northern Continent of the Western Hemisphere. Yet it may be carried almost anywhere. Of all ports, Havana was, for a long time, the most dangerous to the United States, both because of its propinquity and because, under the Spanish rule, all sanitation was disregarded. During the American occupancy, however, subsequent to the Spanish-American War, Havana was freed from this disease by active sanitary and quarantine measures.

This great step, which has saved more lives already than the Spanish-American War (styled by Mr. Taft when President, the "medical war") itself cost, was mainly due to the discovery of the rôle of the mosquito as agent of transmission of the disease. This fact, urged for many years (1881) by Carlos Finlay, of Havana, was ultimately confirmed experimentally in 1900 by Walter Reed and James Carroll, of the United States Army; Aristide Agramonte, of Havana, and Jesse W. Lazear, who died of yellow fever after an experimental bite from an infected mosquito. Briefly, the causation of the disease proved to be an ultramicroscopic animal parasite capable of living in the blood of man and in the body of *Stegomyia fasciata*, which this insect could, through its bite, transmit to man. All but the very young are susceptible to the disease; indeed, it is through the latter that it is perpetuated, since im-

munity is conferred by the first attack. Negroes and creoles are comparatively immune, however, without acquiring the disease. Aliens or strangers visiting a contaminated area are particularly liable to infection.

PATHOLOGY AND PATHOGENESIS.—Surgeon Eugene Wasdin has well shown that post-mortem findings are not sufficiently distinctive to warrant a diagnosis from them alone. Some clue to its identity is afforded, however, by the mixed hepatogenous and hemorrhagic jaundice, the red-tinted serum due to destruction of erythrocytes, the diffusion of the hemoglobin in the plasma, and the fatty degeneration and necrosis between the hepatic cells. We have here, from by viewpoint, the main clues to the nature of a morbid process which can hardly be duplicated in any other acute febrile infection: a rapidly progressive hemolysis and autolysis due to an intense autoprotective reaction incited and perpetuated by the specific virus of the disease.

[This view, which I advanced in 1907 ("Internal Secretions," p. 1873, vol. i), has recently, as far as autolysis of the hepatic cells is concerned, been advocated by Colonel Hunter. See A. Balfour, *Lancet*, May 20, 1916. S.]

PROGNOSIS.—This depends upon the intensity of the morbid process and the resisting power of the patient. The highest mortality averages 87 per cent. Alcoholism, squalor, excessive fatigue, starvation, and other debilitating conditions enhance the mortality. Fortunately, the discovery of the mosquito has afforded the means of preventing the transmission of the disease, as it has, for instance, in the Isthmus of Panama, thanks to the labors of Surgeon-General Gorgas.

PROPHYLAXIS.—This reduces itself to adequate protection against mosquito-bites. It consists in: screening of the bed, verandas and windows; destruction of mosquitoes by removal of breeding places, oiling of surface waters, screening of cisterns, bush clearing; drainage flushing, absolute cleanliness of all backyards, streets, cellars—imposing severe fines if necessary; isolation of cases, suspected cases, and contacts, in screened quarters; prompt dissemination of literature concerning the

disease and individual protection against infection.

TREATMENT.—Although the general impression prevails that nothing will abort the disease, it is probable that the use at the earliest possible moment of the late Surgeon-General Sternberg's advice to give mercuric bichloride, $\frac{1}{60}$ grain (0.001 Gm.), and sodium bicarbonate, $7\frac{1}{2}$ grains (0.5 Gm.), every hour, will do so by enhancing, when it is still time, the autoprotective resources of the body. A hot mustard foot-bath and saline purgative do much to relieve the distressing headache. Calomel is preferred by some. Antipyrin may also be used for the same purpose, or acetphenetidin, if needed. The gastric irritability may be offset with cerium oxalate, but if persistent, cocaine hydrochloride, in doses of $\frac{1}{4}$ grain to $\frac{1}{2}$ grain (0.016 to 0.03 Gm.), every hour or two, often proves efficient. Small quantities of carbonated beverages, as Vichy or very dry champagne, administered ice cold, will often prove of service. Creosote carbonate has also been highly recommended. Considerable relief is also derived from the application to the epigastrium of a liniment composed of olive oil and menthol.

It is preferable to withhold food or give only cracked ice at first, then to begin with milk and Vichy, followed by a bland diet when the patient is better able to take nourishment. Hunter, and more recently Balfour (*Lancet*, May 20, 1916), hold that the autolytic destruction of liver-cells calls for a supply of protein (peptonized enemata of beef-tea, eggs, etc.), and sugar given by mouth or enema in 5 to 10 per cent. solution to compensate for the hepatic failure. When I pointed out, in 1907, that autolysis was the active pathogenic factor in the process, I urged the use of saline solution intravenously to increase the fluidity of the blood. This would not only enhance the elimination of the pathogenic toxin, but the antitoxin process as well. It may also be used for

high enemas. Sponging and cool baths are also recommended. S.

YOHIMBINE.—Yohimbine ($C_{22}H_{30}N_2O_4$) is an alkaloid found in the bark of the yohimbehe tree, indigenous to German West Africa. It occurs in silky needles, readily soluble in alcohol and ether, almost insoluble in water. Its hydrochloride, being water-soluble, is mostly used, in doses of $\frac{1}{12}$ grain (0.005 Gm.), given 3 times daily.

PHYSIOLOGICAL ACTION.—In large doses the drug first stimulates and then paralyzes the central nervous system, especially the cardiac and respiratory centers. The kidneys are unaffected.

Smaller doses produce a dilatation of the blood-vessels of the skin and mucous membranes. Coincidentally, the sexual apparatus becomes congested and erections ensue, probably caused by a direct stimulation of the erection center in the lumbar cord; a sensation of heat and tension in the testicles and scrotum is noticed.

UNTOWARD EFFECTS.—After large or frequently repeated doses, vertigo occurs, with congestion of the ocular vessels, salivation, weakness, chilliness, and sweating. D'Amato reports cardiac palpitation and sleeplessness; these occurring without erections. Loss of appetite, gastric pain, and intestinal colic, and after very large doses a condition of excitement, resembling that due to alcohol, with talkativeness, have been noted.

THERAPEUTIC USES.—Yohimbine possesses anesthetic properties. In a 1 to 2 per cent. solution the hydrochloride has been used in ophthalmology, rhinology and otology.

Its chief use has been in sexual neurasthenia and impotence in the male, and in female disorders marked by a condition of pelvic anemia, as well as in cases of sterility due to genital infantilism. It should be used with care in nervous persons and kidney affections, and is contraindicated in chronic inflammations of the pelvic organs, epididymitis, and chronic prostatitis.

Z

ZINC.—Zincum (U. S. P.) is metallic zinc in the form of thin sheets, in globules (the size of No. 7 shot for arsenic test), granulated pieces, thin pencils, or as zinc dust.

Acetate of zinc occurs in white, lustrous plates, soluble in 2.7 parts of cold and in 1.5 parts of boiling water, and in 36 parts of alcohol.

Carbonate of zinc (precipitated) occurs as an impalpable, white powder, of variable composition and insoluble.

Chloride of zinc (butter of zinc) occurs as a white, deliquescent powder, and is soluble in 0.3 part of water, in alcohol, and also in ether. The official solution of zinc chloride occurs as an astringent, sweetish acid liquid, containing 50 per cent. by weight of zinc chloride. Canquoin's paste is made by mixing zinc chloride with flour and water in a ratio of 1 part of the chloride in 6 parts (weakest) to 1 part in 3 (strongest). When used, 10 or 15 drops of water are added. The stronger paste may be cut into pointed strips or arrows and dried before being used (Maison-neuve).

Oxide of zinc occurs as a white, amorphous powder, having the property of absorbing carbon dioxide from the air. It is soluble in dilute acids, ammonia, and in ammonium carbonate. The official ointment contains 20 per cent. of zinc oxide.

Phenolsulphonate (sulphocarbolate) of zinc occurs in transparent prisms, which are soluble in 1.7 parts water and in alcohol. It is antiseptic, astringent, and is employed externally in 0.5 to 1 per cent. watery solution.

Stearate of zinc occurs in very fine white powder, insoluble in water, alcohol, etc., but readily miscible with

oil and fats. Used as an antiseptic powder and to make the ointment.

Sulphate of zinc (white vitriol; zinc vitriol) occurs in colorless, rhombic crystals, having an astringent, metallic taste; they effloresce in dry air. It is soluble in 0.6 part of cold and in 0.2 part of boiling water, and in 3 parts of glycerin. Villate's solution for treating caries consists of: sulphates of copper and zinc, of each, 15 parts; solution of subacetate of lead, 30 parts; vinegar, 300 parts.

Valerate of zinc occurs in white, glistening laminæ, having a valerianic acid odor and a sweetish taste, and decomposing on exposure. It is soluble in 40 parts of alcohol and in 100 parts of water.

PREPARATIONS AND DOSES.

—**Irritant (Soluble).**—*Zinci acetat*, U. S. P. (acetate of zinc). Dose, 2 to 6 grains (0.13 to 0.4 Gm.).

Zinci chloridum, U. S. P. (chloride of zinc).

Liquor zinci chloridi, U. S. P. (solution of zinc chloride—50 per cent.).

Zinci phenolsulphonas, U. S. P. (sulphocarbolate of zinc). Dose, 2 grains (0.125 Gm.).

Zinci sulphas, U. S. P. (sulphate of zinc). Dose, 1 to 3 grains (0.065 to 0.2 Gm.); emetic, 15 grains (1 Gm.).

Zinci valeras, U. S. P. (valerate of zinc). Dose, $\frac{1}{2}$ to 2 grains (0.03 to 0.13 Gm.).

—**Mild (Insoluble).**—*Zinci oxidum*, U. S. P. (oxide of zinc). Dose, 1 to 5 grains (0.06 to 0.3 Gm.).

Unguentum zinci oxidi, U. S. P. (zinc ointment; zinc oxide 20 per cent.).

Unguentum zinci stearatis, N. F. (zinc stearate 50 per cent.).

Zinci carbonas precipitatus, U. S. P.

(precipitated carbonate of zinc). Dose, 1 to 2 grains (0.06 to 0.13 Gm.); emetic, 10 to 20 grains (0.6 to 1.2 Gm.).

Zinci stearas, U. S. P. (stearate of zinc); used externally.

Zincum, U. S. P. (metallic zinc).

PHYSIOLOGICAL ACTION.—

The common action of the soluble salts of zinc is astringent and irritant.

The chloride, on account of its high diffusion power and great affinity for water, is the most energetic of all. When the cuticle is removed, it penetrates the tissues and destroys them for a considerable depth, producing at first warmth, then burning pain for seven or eight hours, by which time a white eschar is formed which separates in seven to twelve days (Ringer). The chloride is a corrosive poison, and is strongly disinfectant.

The sulphate has a more superficial action upon the tissues. In small doses it increases for a time the appetite and digestion, but later causes catarrh, nausea, and anorexia.

The soluble salts of zinc form insoluble compounds with albumin, condense the tissues, and contract the blood-vessels. They are stimulant and astringent, lessen secretions, and promote reparative action.

The carbonate and oxide, almost insoluble in the animal fluids, are but slightly astringent.

The carbonate in large doses produces some nausea and vomiting. The sulphate, in full doses, acts more speedily, is a safe emetic, producing little prostration or nausea, and, as it generally empties the stomach in one complete evacuation, is the best emetic in cases of poisoning (Ringer). It excites vomiting even when injected into the blood or mixed with

albumin. In large doses it is an irritant poison. The oxide, being insoluble, exerts but little action upon the stomach.

Zinc salts are eliminated slowly by the urine. The chief part may be recovered from the feces, being probably excreted by the intestinal mucous membrane and with the bile.

Experimenting in rabbits, the authors found the gastrointestinal tract to be the chief organ of elimination of zinc. From $\frac{1}{2}$ to $\frac{1}{2}$ the amount given was recovered from its contents and the feces in two to three days. Appreciable amounts were recovered from the liver. It may be either stored in the skin or eliminated through it. Salant, Rieger, and Treuthardt (Jour. of Biol. Chem., May, 1918).

ACUTE POISONING BY ZINC SALTS.—The chloride is an irritant poison, causing heat and a sense of constriction of the throat, a strong metallic taste, a burning pain in the stomach, nausea, vomiting, profound pulse depression, cold clammy sweats, cramps of the leg-muscles, etc. Occasionally nervous symptoms follow. Zinc sulphate in large doses causes vomiting, colicky pains, diarrhea, etc.

Case of a young II-para with chronic endometritis. In 5 days the physician in charge swabbed out the uterus three times with a 10, 15, and 30 per cent. alcoholic solution of zinc chloride. Abdominal symptoms then developed, vomiting, nausea, pain, insomnia, twittings and symptoms of nephritis; after various remissions, she succumbed, 63 days after the cauterization. Buttersack (Monats. f. Geb. u. Gynäk., Jan., 1909).

CHRONIC POISONING.—This is uncommon. The symptoms are muscular palsies, neuritis, and cachexia (Hare). Zinc-smelters, according to Schlockow, rarely live beyond 45, and

die, some of bronchial or gastrointestinal catarrh, others of a peculiar nervous affection which commences with burning superficial pains, exalted sensibility, and reflex activity in the legs, and afterward puts on still more clearly the features of myelitis. A. Sacher found that the intravenous injection of very large doses of zinc salts produces paralysis of the voluntary muscles. Gimlette reported an epidemic of zinc poisoning among the soldiers stationed at Pahang, caused by drinking water collected from roofs covered with galvanized iron. Gastric symptoms predominated over the nervous phenomena.

Treatment of Acute Poisoning.—Alkalies and their carbonates, tannic acid, and albumin, are the chemical antidotes. Siphon out stomach several times with solution of sodium bicarbonate, or give emetic of mustard, 4 drams to 4 fluidounces (15 Gm. to 120 c.c.) of water, or hypodermic of apomorphine hydrochloride, 2 to 4 minims (0.12 to 0.25 c.c.) of a 2 per cent. solution. Give abundance of white of egg and milk. Give tannic acid, 30 grains in 1 fluidounce (2 Gm. in 30 c.c.) of water. Relieve abdominal pain with morphine, $\frac{1}{4}$ grain (0.016 Gm.); laudanum, 15 to 20 minims (1 to 1.3 c.c.), or hot fomentations. Further treatment will be symptomatic.

THERAPEUTICS.—**Gastrointestinal Disorders.**—Zinc oxide is an excellent remedy for gastralgia, and in the summer diarrhea of children $\frac{1}{2}$ to 1 grain (0.03 to 0.06 Gm.) may be combined with 5 to 10 grains (0.3 to 0.6 Gm.) of bismuth subnitrate and 2 to 5 grains (0.13 to 0.3 Gm.) of saccharated pepsin, to be given every 4 to 6 hours. It is also useful in the

chronic diarrhea of children and adults in doses of from 2 to 10 grains (0.13 to 0.6 Gm.). The phenolsulphonate is given internally to produce gastrointestinal antiseptics in diarrhea particularly with fetid stools. In typhoid fever this remedy renders the stools less offensive and tends to check the diarrhea, in doses of 2 to 3 grains (0.13 to 0.20 Gm.) in pill, 4 or 5 times daily. Combined with cascara sagrada, it is useful in cases of constipation with flatulence and auto-intoxication. The sulphate has produced beneficial results in that form of dyspepsia which gives rise to oxaluria, when given in doses of $\frac{1}{2}$ to 2 grains (0.03 to 0.13 Gm.). In chronic diarrhea and dysentery it may be given with opium and ipecac, 1 grain (0.06 Gm.) of each in a pill.

The sulphate is much employed as an emetic in cases of narcotic poisoning; a moderate dose, 6 to 10 grains (0.4 to 0.6 Gm.), well diluted with water, may be given every 15 minutes until emesis occurs.

Respiratory Disorders.—The night-sweats of phthisis are often amenable to a pill containing 3 grains (0.2 Gm.) of zinc oxide and $\frac{1}{2}$ grain (0.03 Gm.) of extract of belladonna, given at bedtime. The oxide has been recommended as a serviceable prophylactic in spasmodic asthma and as a remedy in pertussis, combined with belladonna.

Nervous Disorders.—Zinc has been used in epilepsy and chorea. Epileptiform vertigo and epileptiform angina pectoris, when they arise from some gastric disorders, are sometimes cured by the oxide of zinc. The valerate may be used in nervous headaches, nervous cough, hysterical aphonia, ovarian neuralgia, etc.

Cutaneous Disorders.—In lupus, epitheliomata, and unhealthy ulcers the dried sulphate of zinc may be freely dusted over the parts for its caustic action. For the destruction of malignant growths the chloride in its various forms—as solution, Canquoin's paste, or Maisonneuve's "caustic arrows"—may be employed. Zinc oxide, carbonate, and stearate are useful for their astringent action in weeping eczema, impetigo, herpes, intertrigo, burns, seborrhea, and erythema. The ointment of the oxide is soothing and astringent. Zinc oxide is contraindicated when the skin surface is dry; when the eruption is moist it is useful. Zinc stearate is applied as a dusting powder for burns, either alone or combined with acetanilide (5 to 1). As emphasized by Chaput, peroxide of hydrogen is not durable, and after the oxygen has been liberated nothing remains but water, and water is destructive to the cells. Zinc peroxide is free of these drawbacks.

Catarrhal Disorders.—In catarrhal disorders weak zinc solutions serve after acute symptoms are past. Subacute conjunctivitis is relieved by either the acetate or sulphate, 1 to 2 grains (0.06 to 0.13 Gm.) to the ounce (30 c.c.) of water. The same solution is valuable as an injection in the subacute stage of gonorrhea, gradually strengthened up to 20 grains (1.3 Gm.) of the acetate to the ounce (30 c.c.) of rose-water, until the discharge ceases. Zinc stearate is applied in substance, or combined with menthol (2 per cent.) in urethritis and gonorrhea, in the form of a powder to be insufflated or in bougies.

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ZINGIBER.—Zingiber, or ginger, is the dried rhizome of *Zingiber officinale* (fam. Zingiberaceæ). Ginger contains a volatile oil, to the extent of from 1 to 3 per cent., which is the source of the odor and flavor of the drug, and gingerol, which is very pungent, but not volatile or aromatic, in about one-half the amount of the oil. The volatile oil occurs as a thickish greenish-yellow liquid, very slightly soluble in alcohol (50 to 100 times its weight).

PREPARATIONS AND DOSES.—*Zingiber*, U. S. P. (the root). Dose, 10 to 30 grains (0.6 to 2 Gm.).

Fluidextractum zingiberis, U. S. P. (fluid-extract of ginger). Dose, 5 to 20 minims (0.3 to 1.3 c.c.).

Oleoresina zingiberis, U. S. P. (oleoresin of ginger). Dose, $\frac{1}{2}$ grain (0.03 Gm.).

Syrupus zingiberis, U. S. P. (syrup of ginger). Dose, 1 to 4 drams (4 to 16 c.c.).

Tinctura zingiberis, U. S. P. (tincture, or essence, of ginger, 20 per cent.). Dose, 20 to 60 minims (1.30 to 4 c.c.).

Pulvis rhei compositus, U. S. P. (compound powder of rhubarb—rhubarb, 25; magnesium oxide, 65; ginger, 10 parts). Dose, 10 to 60 grains (0.5 to 4 Gm.).

Pulvis aromaticus, U. S. P. (aromatic powder—cinnamon, 35; ginger, 35; cardamom, 15; nutmeg, 15 parts). Dose, 10 to 30 grains (0.6 to 2 Gm.).

Fluidextractum aromaticum, U. S. P. (aromatic fluidextract). Dose, 10 to 30 minims (0.6 to 2 c.c.).

PHYSIOLOGICAL ACTION.—Ginger is a warm, stimulating carminative. It increases secretions and peristalsis. It is a mild diuretic, and acts as an irritant to the bladder and urethra. Externally it is rubefacient and counterirritant.

THERAPEUTIC USES.—Ginger is useful in atonic dyspepsia, especially in elderly persons. It relieves flatulence and diarrhea. It is a useful addition to bitter tonics. As a rubefacient it is made into a cataplasm, either alone or in combination with other spices (spice plaster) for neuralgia, myalgia, headache, and colic. S.

ZONA. See HERPES ZOSTER.

